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ABSTRACT

The study was conducted to determine the feasibility and value of using broadband communications (transmission of many television, voice and/or data signals through a single system) to provide public services for rural areas. Applications of broadband communications to rural areas were divided into public services (health, education, law enforcement, and governmental/administrative uses) and commercial uses (security systems, information and data transmission, and pay-TV). Each category was examined in terms of: rural needs; experiments conducted in providing the service; and potential rural uses, including their feasibility and value. In addition, tasks were undertaken to: identify rural needs and make a preliminary evaluation of actual and potential applications of broadband communications to meet those needs; determine the present status of rural growth so that the role broadband communications might play could be defined; and identify constraints to, and an approach for, bringing broadband communications to rural areas. Three policy alternatives were identified, briefly considering pros and cons of each. Appendices include: an examination of the health services and needs of rural populations; and a description of the technologies (cable television, translators, telephone, microwave, communications satellite, fiber optics) included in the assessment and the economic factors governing their use. (NQ)

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The Feasibility And Value Of Broadband Communications In Rural Areas

A Preliminary Evaluation

April 1976

U.S. DEPARTMENT OF HEALTH
EDUCATION & WELFARE
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NOTE

Additional copies of this staff report, prepared originally as a working paper for use of the Senate Committee on Agriculture and Forestry, have been published in order to facilitate further discussions of this topic.

PREFACE

In a letter dated June 25, 1974 to the Director of the Office of Technology Assessment, Senator Herman Talmadge, Chairman of the Senate Committee on Agriculture and Forestry asked "if OTA would consider a project to determine the feasibility and value of experimental efforts to develop public service for rural areas through the use of broadband communications techniques." Senator Talmadge further expressed his interest in the contribution broadband communications might make to the broad objective of "rural community development."

Although communications technology has not been designated by the Technology Assessment Board as one of the principal areas for analysis during OTA's early years of operation, it is of central importance to the functioning of our society and is an area that the Board could designate for formal assessment activities in the future. For these reasons, and to provide a basis for response by the Board to Senator Talmadge's specific inquiry, a long-term exploratory study was undertaken by OTA staff. The study had the twin objectives of exploring the relationship between broadband communications and rural development, and identifying what further activities, if any, OTA might undertake in this area. This report is the product of that effort.

At its 13 April 1976 meeting the Technology Assessment Board elected to transmit this report to the Committee on Agriculture and Forestry. Although the report is a specific response to Senator Talmadge's request, it is only a first step and falls short of a full assessment. An approach for additional activities, if desired by the Committee, is outlined at the end of Chapter I.

An earlier draft of this report was reviewed by a number of knowledgeable individuals who contributed many helpful comments and suggestions. These individuals, for whose help the Board is indebted, are as follows:

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This study was conducted by William Mills, Gretchen Kolsrud, and Lucia Turnbull of the Office of Technology Assessment. Consulting assistance was provided by Robert Spongberg of the Denver Research Institute. In addition, many individuals gave freely of their time and knowledge and their assistance is appreciated. These individuals are listed in Appendix B.

INTRODUCTION

The letter from Senator Talmadge which led to this OTA staff study raised two questions that are of profound importance to the future of rural America.

The first has to do with overcoming the problems of low population density and geographic isolation through innovative uses of existing broadband communications technologies. (These are combinations of cable television with two-way capability, ground or satellite based microwave links and/or automatic broadcast repeater stations.) Broadband systems provide a means to link doctor and patient, teacher and pupils, police sub-station and headquarters; in other words, to substitute communications for travel in the delivery of public and commercial services. For these applications, the question raised by the Senate Committee on Agriculture and Forestry is one of feasibility and value -- can such systems be economically feasible in outlying rural areas and, if so, what would be their worth?

The second major question raised by the Committee takes the implications of such uses a step further and asks what contribution their adoption might make to the broad goals of rural development as spelled out in recent legislation. Can broadband systems contribute to the economic development of these regions? How might their widespread adoption affect the balance between rural and urban areas? Might they increase the attractiveness of rural areas as places in which to live?

What gives these inquiries special timeliness are recent events of perhaps historic proportions. For the first time in this century, the exodus from rural areas to cities has been halted. Since 1970, both population and economic growth have been greater in rural than in urban areas. While it cannot be known how long these trends will persist, there currently is momentum for change and new-found prosperity in some rural sections of the country. If these trends are further reinforced by circumventing fundamental rural problems of geographic isolation and low population density through the expanded use of communications, the opportunity might be at hand to help reach the national goal of more balanced growth.

Over the past decade and more, much has been written about the use of communications to decentralize industry to rural areas and in so doing transform the nature of our society. Similarly, a good deal of federally-supported experimentation has been conducted into means for delivering health care, education and other public services through the medium of television and other forms of communication.

In view of the high promise of such innovations, the reality of their actual use has been the more disappointing. To date, almost none of these non-entertainment broadband services have been incorporated into operating cable systems. A 1975 survey by the National Cable Television Association revealed only 31 of 644 operators leasing channels for non-entertainment purposes. Concerning education specifically, in only 5 percent of the systems surveyed was use extensive enough to warrant the exclusive assignment of a channel for this purpose. As of now, not one system exists which offers to outlying rural areas the full range of broadband services that could be supplied.

Relating this experience to the prospects for rural broadband systems, the outlook at first glance is discouraging. Unlike systems in more densely populated urban settings, those in sparsely settled rural areas are not likely to pay their own way if confined to conventional television. In fact, the major barrier to extension of systems beyond town limits has been this reliance upon entertainment services as a principal source of revenue. Where population density of potential subscribers willing to pay $7 or $10 a month for entertainment falls below 30 to 40 per mile, cable extension typically is not economically feasible. However, there may be cause for a more optimistic outlook if public service and commercial uses of broadband are used as additional sources of revenue and combined with subscriber fees from conventional network television.

A cause for optimism in thinking that rural operators might succeed in assembling combinations of services derives from the potential savings to be realized in a rural setting. Because distances and thereby transportation costs are higher, potential savings from reducing student travel might make a given broadband service economically attractive in a farm area where it might not be in a city. Also, because of low population density, a doctor in a rural area might greatly magnify his effectiveness — and income -- through a broadband link to remote clinics, where this is less likely to be so with a city doctor whose patients live close by.

Nonetheless, development of broadband systems in rural areas which exploit all potential uses and revenue sources is a task of considerable magnitude. Regulators and industry alike have tended to be preoccupied with the uses of broadband in densely populated urban areas. The FCC, seeking to encourage the non-entertainment uses of cable, has endorsed the concept that channels should be available for non-entertainment purposes free-of-charge. While this might make sense in a large urban system that can make a profit solely from revenues received from entertainment, it is of little help to a rural system that might depend upon revenue from non-entertainment services as a crucial source of income.

However, despite the apparent logic of a full-service system in which revenue is derived from public services, commercial users and subscriber-based entertainment fees, the concept has not been tested. A limited demonstration program to test this concept would seem to be a natural next step from single service applications of broadband communications which have been so frequent in the past decade. Unlike experimental studies, which have emphasized and demonstrated technical capability to meet public service needs, the objective of the demonstration would be to determine how several services might be combined into an economically viable system. Services would be drawn from the broad classes of subscriber-based entertainment, public service and commercial use as these are needed by the particular community in which the demonstration takes place.

The demonstration program outlined in this study may be contrasted with the approaches outlined in recent studies and in a number of legislative initiatives. These alternate approaches fall into two groups. On the one hand are those which suggest that a large-scale government program, modeled on the Rural Electrification Act of 1934, should be undertaken to make low cost loans available for rural broadband systems. Such programs might be premature when the best way to produce economically viable broadband systems in rural areas has yet to be determined. Alternately, other legislative initiatives have proposed the need for demonstration programs to evaluate public service applications of broadband communications. However, these bills are not directed at rural areas, and the projects would probably not take place in such areas because the funds are for studies on existing systems. Systems with significant channel capacity and two-way capability are generally located in urban areas. The unique needs of rural areas, and the fact that economic viability may rest on differently weighted factors in rural and urban areas, suggest the need for demonstration programs specifically directed at meeting rural needs.

As a final note, this study had its origins in a request for information on the feasibility and value of employing broadband communications to deliver public services and contribute to the objectives of rural development. Having found that these subjects are relatively unexplored, the study does not resolve these questions but instead describes an approach for seeking out the answers. Additionally, it gives one view of the role of broadband communications in rural development as well as of the steps that might be taken to further their deployment. What action might be taken in connection with the latter, of course, will depend upon broader considerations of federal policy towards rural development.

TABLE OF CONTENTS

CHAPTER I - SUMMARY I-1

CHAPTER II - PUBLIC SERVICE AND COMMERCIAL USES OF BROADBAND COMMUNICATIONS IN RURAL AREAS II-1

- Public Service Applications II-2
  - Health II-2
  - Education II-30
  - Law Enforcement II-46
  - Governmental Administrative Uses II-52
- Commercial Applications II-52
  - Security Services II-54
  - Information Services II-61
  - Data Transmission II-66
  - Pay Television II-75
- Summary And Discussion II-79

CHAPTER III - RURAL DEVELOPMENT AND BROADBAND COMMUNICATIONS III-1

- Rural-Urban Population Distribution And Migration Patterns III-2
- Factors Underlying Rural Development III-8
  - Decentralization Of Manufacturing III-8
  - Decentralization Of The Service Sector Of The Economy III-11
  - Residential Preference III-14

p xii blank

Rural Needs And Broadband Communications..........III-18

Turnaround Acceleration Counties.............III-18

Turnaround Reversal Counties.................III-28

Declining Counties...........................III-33

Summary And Discussion Of Findings...........III-47

CHAPTER IV - A SYSTEM APPROACH TO DEVELOPING AND ASSESSING RURAL BROADBAND COMMUNICATIONS..........III-1

What Is Meant By A System Approach................ IV-1

Case Studies....................................... IV-3

Trempealeau County, Wisconsin Project........ IV-4

Spartanburg, South Carolina Project.......... IV-19

Constraints To Wider Application Of Broadband Communications In Rural Areas........... IV-32

Technology................................. IV-32

Regulation................................. IV-35

Economic Constraints........................ IV-47

Summary Of Findings................................ IV-52

The Need For System Demonstrations................ IV-55

An Approach To Implementation Of System Demonstrations............................. IV-58

Responsible Agencies........................ IV-61

Funding Mechanisms.......................... IV-63

Identification Of Potential Sites And Dissemination Of The System Demonstration Concept..................................... IV-68

Types Of Sites.............................. IV-69

Investigation Of The Impacts Of Widespread Implementation Of Telecommunications In Rural Areas...................................... IV-70

A Future Course Of Action If System Demonstrations Prove Successful................... IV-73

Previous Legislative Initiatives And Findings From Other Studies............................... IV-76

Whitehead Report............................ IV-79

S.1219, H.R. 5319, H.R. 244 .... IV-80

Cable Television: Promise Vs. Regulatory Performance IV-81

H.R. 4564, S. 1257, H.R. 9630 .... IV-83

Telecommunications Technology Act of 1975 (H.R. 9289) IV-84

A Preliminary Review Of Current Practices And Trends In Rural Telecommunications: A Report IV-85

Summary IV-88

Policy Alternatives For Applications Of Broadband Telecommunications To Rural Areas IV-90

Continue Status Quo IV-90

Fund A Limited Number Of System Demonstration Projects IV-93

Create A Federal Mechanism To Facilitate Wide Dissemination Of Broadband Services In Rural Areas IV-95

Future OTA Role IV-97

APPENDIX A A-1

APPENDIX B B-1

APPENDIX C C-1

APPENDIX D D-1

CHAPTER I

SUMMARY

This staff study was undertaken by the Office of Technology Assessment in response to a request from Senator Talmadge of the U.S. Senate Committee on Agriculture and Forestry. Senator Talmadge expressed his concern for "equity for rural people" and asked that OTA consider undertaking a technology assessment to determine the feasibility and value of using broadband communications to provide public services for rural areas. Senator Talmadge further indicated his interest in the contribution broadband communications might make to the broad objectives of "rural community development".

In the course of this staff review, the following tasks were undertaken:

- identify rural needs and make a preliminary evaluation of actual and potential applications of broadband communications to meet those needs;
- determine the present status of rural growth so that the role broadband communications might play could be defined; and,
- identify constraints to, and an approach for, bringing broadband communications to rural areas.

Each of these topics is dealt with in Chapters II, III, and IV, respectively. Chapter IV also identifies policy alternatives and describes an approach for further OTA assessment activities if such are considered desirable by the OTA Board or by the Senate Committee on Agriculture and Forestry or by other committees of the Congress.

This Chapter begins by defining the scope of the study in terms of the types of communications technologies included. The meanings of the terms "rural" and "urban" are also described. Major findings concerning each of the tasks identified above are then summarized.

Definitions And Scope

"Broadband" communications refers to transmission of many television, voice and/or data signals through a single system. The transmission may be through the atmosphere or through wires or glass fibers. There is no clear point of separation between broad and narrowband. For the purposes of this study, the term "broadband" indicates a communications system employing one or more of the following technologies: coaxial cable, translators, ground or satellite-based microwave relays, and fiber optics. Technologies outside the scope of this study include conventional two-way telephone, radio and TV broadcasting stations and mobile radio. In general, the term broadband as used in this report implies two-way interaction with video, as well as voice and/or data in at least one direction.

There are a number of definitions of "rural" and "urban" (see Chapter III, page 3). Because available data on population trends are organized by counties which are classified as "nonmetropolitan" and "metropolitan", these terms are used rather than rural and urban when discussing population trends. When the discussion is more general, the term rural rather than nonmetropolitan is frequently used. A metropolitan county is defined as one in which there is an urban nucleus of at least 50,000 people. Adjacent counties are included if 30% or more of the population commute to the urban core. If less than

30% but more than 15% of the workers commute, the adjacent county is still considered metro if it meets two out of three subsidiary criteria considered characteristic of metro areas. These criteria refer to density, degree of urbanization and rate of growth. Other areas are classified as nonmetropolitan.

Previous Applications Of Broadband Communications

Applications of broadband communications to rural areas can be divided into two categories: 1) public services (including health, education, law enforcement, and governmental/administrative services); and, 2) commercial uses (including security systems, information transmission, data transmission and pay-TV). For each application, the following were reviewed: 1) rural needs; 2) experiments conducted in providing the service; and 3) potential rural uses, including their feasibility and value. The analysis suggested the following major findings.

Public Service Applications

In both health and education, rural needs derive from shortages and inadequacies of facilities and personnel as well as from many factors that make access difficult, such as distances to be travelled. Financial resources, that is, lower incomes than in urban areas, the fact that fewer residents are insured for health care, and the generally smaller tax base available to support facilities also contribute to the reduced opportunity for health care and education in rural areas.

In health, a vigorous experimental program conducted over the last twelve years has demonstrated the feasibility of using broadband communications to meet rural needs in five basic areas of health care; namely, consultation, supervision, direct patient care, administration and management, and education and training. Patient acceptance is high and it has been demonstrated that telemedicine can increase the adequacy of health care by providing access to services which were not available before or which were only minimally available. Health services personnel cite some problems, especially concern with privacy and confidentiality, but generally, their attitudes towards telemedicine are favorable. Unknowns requiring further research include the costs and benefits of video compared to non-video systems and methods to combine manpower and technology into total health care delivery systems that can be self-sustaining financially.

Fewer experiments using two-way communications have been conducted in the field of education, especially in rural areas. Nonetheless, the technical feasibility of meeting many of the educational needs of rural areas has been demonstrated. There is, however, a lack of information concerning which kinds of hardware and software best support educational uses, as well as concerning the relative effectiveness of education using broadband communications as compared to the traditional classroom. Educational programs adapted to broadband use and/or guidelines for their development are also needed. Generally, very little hard data are available on the cost-effectiveness of using broadband communications for education.

Rural needs in law enforcement derive from the long distances involved and the time consumed in travel to and from the central station, thus reducing the time available for assigned duties. Broadband communications could be used to televise roll calls and briefing sessions, transmit fingerprints and related documents and aid in the conduct of pre-trial arraignments.

Governmental and administrative uses are also potential areas of application. For example, where processing of applications requires more than one agency, broadband communications could reduce requirements for travel and time for processing, thereby reducing costs to local governments and serving clients more efficiently.

Hard data on the economic tradeoffs of using broadband communications to meet needs in law enforcement and governmental/administrative activities are not available for any setting, urban or rural. However, at least one experiment is underway in each of these applications which should provide some data on their feasibility and value.

Commercial Applications

Potential security services include detection of fire and of unlawful entry, both of which are sources of major economic loss in rural areas. Broadband systems could be used to reduce these losses by permitting continuous monitoring of isolated buildings from a central location. Such systems are presently being installed in some new communities, but the economic viability of these systems in rural areas remains to be tested.

In the area of information, services are available which provide stock and commodities prices, round-the-clock news and other information. If the necessary market exists, these could be readily delivered by rural broadband systems.

As for business uses of broadband systems, the potential of high volume data transmission and of automatic meter reading were examined. A working system in New York City uses the excess channels of a local cable television system for transmitting massive amounts of information between a central bank office and many branches. The bank pays a fee to the cable company for its use of the system.

The potential for automatic meter reading arises from the fact that manual reading of meters for water, gas and electricity is especially costly in rural areas because of the distances between houses. A recent study indicates that the cost of manual meter reading will exceed that of automatic meter reading via cable by the end of the decade.

The final commercial application reviewed was pay-TV, for which subscribers pay a fee to obtain special programs and sports events.

The economic viability of these commercial uses in rural areas has yet to be proved. However, they represent potential sources of revenue which could be used to support a rural broadband system.

Discussion

A major purpose of many broadband communications experiments in public services has been to demonstrate technical capability. Economic feasibility and the design of economically viable systems have received less attention. When cost-effectiveness has been considered, it has been limited to the use of technology to provide a single service. As will be discussed later, detailed consideration of a system approach to broadband communications in which costs are shared and revenues are generated by public users, commercial users and subscriber-supported entertainment fees has not been attempted. However, such a system approach may be the key to an economically viable broadband system which could serve an entire rural community.

All of the public service and commercial uses indicated previously and more fully described in Chapter II have potential for inclusion in a rural broadband communications system. Selection of applications for a particular community should be based on a comprehensive needs analysis. The particular public services and commercial uses will vary according to the characteristics of each rural area.

Rural Development And Broadband Communications

In approaching the task of examining the contribution broadband communications can make to rural development, it first was necessary to examine the present nature of change in rural America.

The 1970's has seen a reversal of the historic migration of Americans from rural to urban areas, with a net 1.6 million persons moving from urban to rural areas. This growth is not distributed evenly among all rural areas, nor was it found to be explainable in terms of simple proximity to metropolitan areas: the largest quantitative increase in net inmigration occurred in counties adjacent to metropolitan areas, but the sharpest turnaround in migration developed in the more distant rural counties.

This change, however, has not altered the sizable differences that exist among rural areas. In parallel with the finding that there is no simple way to describe rural America is this study's proposition that broadband communications systems will succeed or fail to the degree that their characteristics match the varying needs and economic conditions of each rural area in which they are located.

In trying to make sense of the great diversity of needs and conditions in rural America, this study first identified the major forces underlying present change and then projected the future course of development and needs that are likely to emerge as a result of these forces.

The three principle forces identified in this study were:

- decentralization of manufacturing;
- decentralization of the service sector of the economy; and
- residential preference.

These forces and proximity to metropolitan areas can be related to the two major categories of growing rural counties. These are (see Chapter III):

- "Turnaround Acceleration" -- counties in which growth began in the 1950's and "accelerated" in the 1960's; generally adjacent to metropolitan areas and characterized by growth in service industries.

- "Turnaround Reversal" -- counties which have only recently "reversed" their decline and generally began to grow in the 1960's; generally not adjacent to metropolitan areas and characterized by growth in manufacturing industries.

The third force, residential preference, has contributed to growth in both categories of counties.

The following summary observations outline the implications of the varying course of rural development for the feasibility and role of rural broadband systems. Also highlighted is the contribution that broadband might make in resolving future needs in the two categories of growing counties plus, for completeness, a third category of rural counties that are declining. ("County" is used as the unit of analysis because most statistics are gathered on this basis. In practice, broadband systems could encompass several counties of varying character.)

- In any rural county, an area-coverage broadband system will require the fullest development of every possible service (entertainment, public, as well as commercial) as sources of revenue if such systems are to be feasible. Leaving aside entertainment as a common denominator in all systems, the principal additional source of revenue will vary according to the type of rural area:

  1) in the fastest growing rural counties (those dominated by growth in the service sector of the economy), business and commercial services are likely to offer the greatest potential sources of revenue.

    2) in growing rural counties characterized by growth in manufacturing employment, public services are likely to constitute the best additional source for revenue.

- Broadband systems in growing rural counties could:

    1) enable greater dispersal of service-type industries than is presently the case in some of the fastest growing counties. This could permit more equal sharing in the fruits of growth by all sections of a county and make more likely the continued viability of smaller rural communities.

    2) help forestall continuing erosion of business functions in those small towns located in areas of manufacturing growth, and provide the communications network necessary for later growth in the service sector, should economic conditions permit.

- Broadband systems in declining rural counties could:

    1) contribute to the cost-effective functioning of federal and state programs designed to upgrade medical, educational and other community services.

    2) help to attract new industries by serving as a vehicle for delivery of upgraded community services.

- Implications for government policy are:

    1) in growing rural counties, broadband systems have the potential for becoming self-supporting; assistance required in their

development is likely to be in the areas of technical aid and securing of financing.

2) in declining rural counties the economic base is likely to be inadequate to support broadband systems. However, to the extent that government subsidies might be made available to upgrade schools and community facilities, some functions might be performed through the use of broadband and appropriate reimbursement made to the system. The latter revenues, in turn, might be sufficient to make the system financially self-supporting. The value of broadband in providing public services is likely to depend upon the extent to which these services mesh with and contribute to government assistance programs, as well as upon the degree to which rural development policy emphasizes area-wide, coordinated delivery of community services.

- Despite the evident promise of broadband communications systems, there can be no assurance that they will evolve in the manner suggested above. Before entrepreneurs, local business leaders, or governmental officials can seriously entertain organizing and deploying such systems, much more has to be known about the practical aspects of their financing and operation. This will be examined next.

Constraints To Rural Applications Of Broadband Communications

Given the high potential of broadband to meet rural needs, it is noteworthy that there have been so few applications providing services other than conventional television. Three categories of potential constraints were examined: technology, FCC regulations and cost. Technology is not limiting. FCC regulations do provide some constraint. For example, relaxation of restrictions on translators, so that they could rebroadcast signals received from ground or satellite-based microwave relays, would encourage wider use of this technology.

While FCC regulations do not directly inhibit use of cable for public services, the regulation that public service channels should be provided free of charge in some rural areas adjacent to metro areas could have the effect of eliminating a vital and necessary source of revenue for rural systems. The free channel regulation may also have inhibited using public services as a source of revenue even in those rural areas where the regulation does not apply. Therefore, although the FCC has sought to encourage development of nonentertainment uses with free channels, the regulations may have had the opposite effect and made it impossible for rural areas to afford either broadband systems or new services.

While regulatory constraints can be removed simply by changing the regulations in question, the third constraint, cost, is a more fundamental barrier. However, it is unclear whether this constraint is actual or perceived. For example, while the low density of rural populations makes use of broadband to provide conventional television economically less attractive than in urban areas, the same low density could well favor it for public service and institutional use. If these nonentertainment uses have value, appropriate fees could be charged which would increase the economic base of the broadband system. However, this approach has not been explored.

A System Approach To Developing And Assessing Rural Broadband Communications

By a rural broadband "*system*" is meant an area-wide communications network accessible to all residents and institutions. The system may be used to meet health, education and other social service needs, facilitate government and administrative transactions, and serve commercial enterprises as well as provide network TV and entertainment. Thus a package of services would be provided and it is suggested that the combination as a whole may be economically viable, where an individual service by itself may not be.

A project being initiated in Trempealeau County illustrates the system approach. A county-wide cable and microwave system available to all residents has been planned. An institution, the schools, will also use the system with the objectives of improving the quality of education, reducing teacher costs and saving funds now spent to transport pupils among schools. While an early feasibility study showed that a conventional individual subscriber supported cable system would not be economically feasible, the addition of revenues from the school users ($9000/year from each of eight schools) sufficiently improved the financial outlook so as to make the system possible.

At the present time, a massive government program to support rural broadband systems might be premature. While planning is well underway for such a system in Trempealeau County, Wisconsin, no full-service area-coverage system presently exists anywhere in the United States. It thus does not appear that enough is known about the detailed nature, feasibility, and value of such systems to encourage their present widespread deployment by means of routine and standard operating programs.

Instead of a large-scale government program, the logical next step would seem to be a series of system demonstrations in which broadband services are tailored to meet the specific and different needs of individual rural localities. Different services will have different cost-effectiveness ratios depending on the demographic, socioeconomic and institutional characteristics of the community. System demonstrations can provide data on what works, where, and under what conditions.

Assuming that a decision might be made to provide federal assistance for these demonstrations, the following basic steps would need to be taken:

- designation of a Federal agency (or agencies) to administer the program, collect data and evaluate results;
- provision of a funding mechanism(s); and
- identification of potential demonstration sites.

Responsible Agencies

In considering agencies that might be assigned responsibilities for system demonstrations, the need for an effective planning organization at the local level should not be overlooked. In some areas, such as Trempealeau County, cooperatives may be so pervasive that they can unite most of the population and the local government in the organizational effort necessary to plan for and implement a broadband system. In others, something akin to the multi-county planning districts being established in several states might provide technical assistance and direction.

At the Federal level, it is clear that a great deal of attention will have to be given to devising an effective means of direction and coordination. Listing only a few of the possible institutional mechanisms, an inter-agency task force could be appointed to oversee Federal participation in demonstrations. Or, a policy board comprised of representatives from executive agencies and rural and industry interest groups could be designated to design and supervise demonstrations in accordance with broad legislative guidelines.

It is beyond the purview of this study to examine fully these and other alternatives. The approach taken here is to outline one simplified alternative in which oversight is provided by existing Congressional committees (possibly with the assistance of OTA, as described in Chapter IV).

Many agencies have been involved in telecommunications research, including NASA and HEW. However, there are three, for the reasons described below, that might be initially considered for major roles in the demonstration phase. These are: 1) the National Science Foundation (NSF); 2) the Department of Commerce; and, 3) the Department of Agriculture.

The National Science Foundation has taken the lead in "systematic experimentation" with its Phase I design and Phase II implementation studies of public services via broadband communications and might be considered for the lead role in conducting system demonstrations as a natural follow-on to these efforts. NSF could also be primarily responsible for collection of data on one of the three major areas to be included in every system demonstration. These three areas are: 1) public service; 2) business and commercial use; and 3) impact on rural life. While as lead agency NSF might coordinate the administration, data collection and evaluation of the overall program, it could also be primarily responsible for the first of the areas enumerated; that is, the public service sector of the demonstrations.

Potential business and commercial use of a broadband system seems to fall within the province of the Department of Commerce. The Economic Development Administration of that Department recently funded a study to help "in determining national policy regarding the future course of telecommunications research and development as related to rural ecomomic development". Thus, the Department of Commerce appears to have the interest, as well as the mandate, to contribute to business and commercial uses in system demonstrations.

The Department of Agriculture is presently a source of loans and loan guarantees (under the Rural Development Act of 1972) for broadband projects and is an authoritative source of detailed knowledge on rural development in general and potential demonstration sites in particular. A significant part of system demonstrations must be evaluation of the impact of expanded telecommunications services on rural growth and on the distinctive characteristics of life (both positive and negative) in rural areas. The Economic Research Service, which was a major source of information for Chapter III, could contribute to development of rural impact data.

In addition, the Department of Agriculture, through its Extension Service, might play a significant role in making known the system demonstration concept to potential rural sites.

Funding Mechanisms

There are two aspects of funding which should be considered: 1) capital resources for construction of systems; and, 2) funds which can be used for identifying demonstration sites; developing software and materials for public service, commercial and other system demonstration uses; operating and maintaining the system; and conducting evaluations.

For capital construction of telecommunications plant, an existing source of funds is Community Facilities loans under Title I of the Rural Development Act of 1972. (Another possible source, as suggested by some, might be the Rural Electrification Administration.) The second category of funds which are primarily to be used for conducting and evaluating the actual system demonstrations could be provided through the lead agency, either as outright grants or loans. Calculations of the potential costs to support four system demonstrations were made. Assuming loans for construction and grants for other costs, per year costs for a five-year program were estimated at roughly $1.8 million.

Candidate Sites

Only one criterion might be universally applied to all candidate rural areas which might wish to serve as a system demonstration site. That is, there must be a high degree of community support for the system. Institutional and public service use of broadband is novel and unfamiliar. As shown in Trempealeau County, individuals within the community in question will have to work together to define common needs which can be best met through broadband services. They will also have to be capable of recognizing the economic value of these services and support the system accordingly, (e.g., tax monies used to support schools might be used for broadband educational services). Several types of sites for system demonstrations were identified in the course of this study and are discussed in the body of this report.

Investigation Of The Impacts Of Widespread Implementation Of Telecommunications In Rural Areas

Widespread implementation of telecommunications systems with the characteristics described in this report could have major consequences not only for rural areas but also for urban areas. Changes brought to rural areas through broadband might be positive or negative. Thus, definition of impact areas, and development of a plan for evaluation of the potential positive and negative consequences of widespread telecommunications systems, should be an integral part of any system demonstration program. While detailed consideration of this topic is beyond the scope of this staff study, a representative listing of the impact areas that might be pertinent was developed. These fall into the six major categories of population balance, economic impacts, social impacts, institutional impacts, transportation-telecommunications tradeoffs, and longer term impact areas.

A Future Course Of Action If System Demonstrations Prove Successful

If system demonstrations prove the feasibility of community-wide broadband systems to meet a variety of rural needs and if it is judged that the positive and negative impacts of such systems are, on balance, favorable for national growth and development, then funding services for implementing such systems on a broad scale might be sought. One solution might be to establish a Federal program modeled on the Rural Electrification Administration which brought electricity and telephone to rural areas through low cost loans. However, in the case of rural broadband systems, a more flexible approach involving several different funding mechanisms appropriate to the different economic characteristics of rural America might be considered (and evaluated further during the system demonstration phase).

This funding could be related to the Turnaround Acceleration, Turnaround Reversal and Declining county categories cited earlier as a framework for analysis. (It should be noted again that the "county" is the unit of analysis because most statistics are gathered on a county basis. In practice, broadband systems could encompass several counties of varying characters.) Because of the differing attractiveness of these types of rural counties to private entrepreneurs, the system operator might also be expected to vary. For example, funding mechanisms and owner/operators might vary with the category of rural county as indicated below:

County Type	Federal Financing Mechanism	System Owner/Operator
Turnaround Acceleration	Guaranteed Loan	Private Industry
Turnaround Reversal	Direct Loan	Rural Cooperative
Declining	Government Subsidy	Private Industry/ Local Government

Sources of funds include the Business and Industrial Division of the Department of Agriculture for guaranteed loans, and Community Facilities loans under Title I of the Rural Development Act of 1972 which are direct loans. Both of these sources have already been used to support rural broadband systems. In this connection, however, it is important to note that a letter sent to OTA by the Department of Agriculture stated that "...we do not anticipate this type of loan becoming a significant part of our community facility loan program."

Previous Legislative Initiatives
And Findings From Other Studies

A number of bills and studies were reviewed. These may be divided into three groups depending on their treatment of the problem of bringing broadband communications to rural areas.

The Whitehead Report exemplifies the class of national cable policy studies. Within this class, rural cable is treated more as a monitoring problem than as a problem requiring action. Thus, it is not surprising that no specific course is outlined nor is a funding mechanism proposed for bringing cable to rural areas.

The second group of bills and studies includes S. 1219, H.R. 5319, H.R. 244, the Interstate and Foreign Commerce Subcommittee report on cable and the Booker T. Washington/Cablecommunications Resource Center report on rural telecommunications. This group of bills and studies suggests that telecommunications should be brought to rural areas now and suggests low-cost, long-term loans as the funding mechanism. The implication is that the major constraint on rural telecommunications is lack of risk capital and that the problem can be solved in a manner paralleling the Rural Electrification Act of 1934 which enabled the spread of electricity and telephone service to rural areas. However, the parallel between these two situations may not be as exact as it appears. For cable, content is all important whereas the consumer supplies the uses for electricity or the content carried by telephones. Whether enough is presently known about program content to ensure success of rural broadband systems is unclear.

The third group of bills includes H.R. 4564, S. 1257 and H.R. 9630. This group specifically addresses the problem of providing new services, such as public service applications, via telecommunications and proposes demonstration programs which would enable evaluation of such services. Unlike the second group, these bills are not directed at rural areas and projects probably would not take place in rural areas. This is because the funds, when specified, are to be used for studying methods for bringing in the service. Existing systems would be used in the demonstrations and those with significant capacity -- as for two-way use -- are located in urban areas.

This report combines and extends the concepts in all these groups of bills and studies in that it proposes a limited demonstration program, specifically for rural areas, aimed at investigating the feasibility and value of combinations of public services, commercial uses and entertainment.

Policy Alternatives For Applications Of Broadband Telecommunications To Rural Areas

Three policy alternatives were developed during the study. These are:

- continue the status quo;
- fund a limited number of system demonstration projects; and
- create a Federal mechanism to facilitate wide dissemination of broadband services to rural areas.

The pros and cons of each of the policy alternatives are described in Chapter IV of this report.

Future OTA Role

As stated in the Preface, the objective of this staff study was to provide a basis upon which the Technology Assessment Board might decide what contribution, if any, OTA could make in assisting the Senate Committee on Agriculture and Forestry to evaluate the feasibility and value of rural broadband communications.

In the course of the study, the subject of rural broadband communications was found to be relatively unexplored. In particular, no analyses were found which considered the utility of broadband in relation to the fundamental factors underlying the sudden reversal of growth trends in rural America depicted in most recent Census statistics. Therefore, in order to gain some clear understanding of what OTA might do in connection with the subject, it first was necessary to originate a means of relating broadband to the forces underlying this change. Subsequently, it was necessary to consider how and whether such systems could actually be deployed and their value assessed.

Because of these somewhat unique circumstances, this study does not constitute a simple reply to Senator Talmadge's query as to how OTA can be of assistance. Instead, what is reflected in this staff study is a possible course of action which the Senate Agriculture Committee might weigh. OTA's future role and the specific form its assistance might take, therefore, will depend upon the Committee's judgment as to how many of the three tasks spelled out herein, if any, it might wish OTA to pursue.

With these qualifications in mind, the following is a three-task approach to OTA's participation that the Senate Committee might consider:

First as an adjunct to hearings the Committee might wish to conduct, OTA could help the Committee to assemble a panel(s) to examine and verify or refute the findings described in this report. Topics to be covered could include:

- the present and probable future trends in rural growth;
- the impact of broadband communications on probable growth trends;
- constraints to wider application of broadband communications in rural areas;
- the need for system demonstrations and the number and type of system demonstrations which should be conducted, including criteria for site selection;
- consideration of the possible need for, and best form of, Federal involvement in rural broadband applications in the system demonstration phase as well as in subsequent programs; and
- consideration of the possible role of OTA in helping the Committee to assess and monitor the programs suggested above.

Second, OTA might begin a continuing assessment program to help the committee monitor: 1) telecommunications experiments in or applicable to rural areas; and, 2) the progress of the Trempealeau County project and any system demonstrations undertaken. With regard to the second task, a critical feature would be assessing the impact of telecommunications on the characteristics of life in rural areas affected. (Assessing whether these impacts might be desirable is outside the scope of OTA activities. The purpose of this monitoring effort would be to provide the committee with data from which a judgment could be made.)

Third, on an as-needed basis, small assessments involving either panels or other mechanisms could be conducted to integrate the data of the monitoring efforts with other data, including the preliminary findings of this study.

Because any system demonstration will require several years, what is proposed here is a long-term, relatively low-cost activity. An estimated level of effort and cost is as follows:

- ½ manyear/year of senior staff = $17,000
- ½ manyear/year of support staff = 9,000
- 1/3 manyear/year of secretarial support = 5,000
- average yearly cost of panels, small contracts, etc. = 30,000
- contingencies including staff travel = 4,000

$65,000/year

It is anticipated that OTA's participation in the project would be reviewed by the Technology Assessment Board at least biyearly. At these times, both the progress and the adequacy of OTA's effort would be subjects of evaluation.

CHAPTER II

PUBLIC SERVICE AND COMMERCIAL USES OF BROADBAND COMMUNICATIONS IN RURAL AREAS

This Chapter examines the potential of broadband communications for responding to rural needs, both in the public service sector and as they relate to rural economics. Each application is considered individually, with a view towards determining whether current experiments are grounded in a realistic appreciation of rural needs and, secondly, whether they are designed to produce the kind of data necessary to determine their ultimate feasibility in functioning rural systems. Later chapters will describe how these services might be combined to support a rural broadband system which could contribute to the broad goals of rural development.

The following categories of broadband applications are addressed:

- public service (health, education, law enforcement, governmental/administrative uses); and
- commercial (security systems, information services, data transmission, pay-TV).

Each of these categories is examined in terms of:

- rural needs for the service tested;
- representative experiments conducted; and

- potential rural applications including the feasibility and value of the service in meeting rural needs.

It should be noted that several recent studies, notably those by Peg Kay, Social Services and Cable TV (1)[1] and by the Cablecommunications Resource Center, A Preliminary Review of Current Practices And Trends In Rural Telecommunications Development And Recommendations For Future Development (2), have reviewed experiments for the applications considered in this Chapter. No attempt is made here to duplicate these efforts and the reader is referred to them for additional information.

Public Service Applications

Health

Major studies analyzing rural health needs and relating these to existing and potential broadband applications have not been done. As part of this study, a preliminary analysis of these needs was attempted and is summarized below. However, the results are not definitive and additional research is required.

Rural needs. Appendix C contains an analysis of health conditions, health manpower and facilities resources, utilization of resources by rural populations and Federal initiatives in delivering rural health needs. The following brief summary is drawn from Appendix C.

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[1] References are numbered consecutively in the order of their first appearance in the text. The first number is the reference. The number after the dash is the page number in the reference.

Significant health care problems exist in rural populations. Comparative analysis of the health of rural vs. urban populations shows higher infant and maternal mortality rates and greater incidence of chronic illness in rural populations.

Another indicator of rural health is the rejection rate for military service from physical and mental conditions. The rate for rural residents is at least twice that for metro residents and residents of small cities and towns.

As for injuries, rural nonfarm residents show higher injury rates than metro residents. However farm residents show a lower incidence of injuries. Thus, medical care requirements for injuries in rural as compared to urban areas are not clearcut.

There is a shortage of physicians, especially specialists, in rural areas. The combined ratio of general practitioners, specialists and hospital-based physicians per 100,000 population is 69.0 for nonmetro areas and 145.7 for metro areas. For specialists alone per 100,000 population, the ratio is 30.3 for nonmetro areas and 81.5 for metro areas. Dentists, pharmacists and registered nurses are also in very short supply in nonmetro compared to metro areas. Contributing factors to the rural shortage of medical personnel include isolation from peers, and the difficulty in remaining current in professional specialties due to lack of ready access to facilities equipped with the latest instruments and technology, as well as to specialists for referral and consultation. Also of significance is the greater workload associated with attending a larger group of people who are also widely distributed.

As for health facilities, statistics show that there is a greater number of community and psychiatric hospital beds per capita for rural populations compared to urban populations. However, the accessibility of these facilities in terms of location, available transportation systems and costs for utilizing them present severe problems for many individuals residing in rural areas. In addition to having lower income levels, the percentage of persons covered by hospital and surgical insurance is also lower in rural areas than in urban areas.

Studies of the utilization of health services by rural residents show that the latter tend to visit physicians, specialists and dentists with less frequency than urban residents. Because hospitalization rates for rural nonfarm residents and rural farm residents over 65 are proportionately higher than for metropolitan populations, it is unlikely that this lower utilization of health services reflects better health of rural residents but is more likely a function of access and a tendency to allow conditions to become more serious before medical attention is sought.

A related problem is availability of emergency medical services. Difficulties arising from health manpower shortages, distance to health facilities and access to transportation suggest inadequacy of emergency medical services.

In summary, available information on health conditions, resources and services points to inadequacies of health care delivery systems in rural areas. The needs of rural populations in health care delivery systems include:

- need for increased primary health and dental services based on evidence of fewer physicians per capita, higher hospitalization rates, greater incidence of infant and maternal mortality, and higher incidence of medical disqualification for military duty;

- need for less expensive medical care and improved physical accessibility to medical facilities and services due to maldistribution of facilities and physicians, the distances rural people must travel, inadequate transportation services or alternatives, and low membership in health insurance plans as well as relatively lower income levels as compared to urban areas;
- need for emergency medical services due to chronic illness conditions, injury rates, and distances to facilities; and
- need for continuing medical education for physicians, specialists and allied health manpower because of physician isolation, physician (specialist) shortages, and difficulty of access for consultations and referrals.

In light of these needs, it is important to evaluate existing communications experiments as a health service delivery tool for rural populations.

Experiments. Representative telemedicine experiments of likely application in rural areas are listed in Table I, which summarizes the funding source, location of the project (that is, urban or rural), operational status, technological characteristics and medical services provided in the sixteen telemedicine experiments evaluated.

As shown in the table, most projects have been supported by the Federal government. The Department of Health, Education and Welfare has been a major supporter of telemedicine projects and NASA and the National Science Foundation have also provided funds. A noteworthy exception is the Blue Hill project (the ninth project in Table 1) which involves a broadband link between a hospital in Blue Hill, Maine, and a nurse practitioner in the isolated community of Deer Isle. This project was originally funded by the Maine Regional Medical Program but increasingly support is being provided by the community of Deer Isle.

Some experiments analyzed are located in urban areas. Although the emphasis in this study is on rural applications, urban experiments have been included to provide a broader data base for assessing the value of telemedicine efforts.

The table also shows that a variety of technologies have been used and combined in various ways. Picturephones have been used. Black and white or color television terminals have been connected by cable and/or microwave and/or satellite. The common denominator of the technologies used is that they have permitted two-way (interactive) exchange of information between sender and receiver, generally in both audio and visual modes.

Of particular interest are the health services provided in the experiments, which are indicated in the last column of the table. Following Rockoff (3-22), these services can be classified in five categories: consultation, supervision, direct patient care, administration and management, and education and training. The table lists services in terms of these five categories. Additional descriptive terms have also been used (such as lab tests, prescription and record transmission, etc.) to provide more detail on the specific services provided. As can be seen,

TABLE I
TELEMEDICINE PROJECTS

Experiments	Funded by	Location	Operational Status	Technology	Services
Massachusetts General/Logan Airport/Bedford Veterans Hospital (4-108ff, 205ff.)	HEW Veterans Admin.	Urban	Bedford still operational Logan operational to a minimal extent	Microwave, cable, black and white, telemetry (ECG's, EEG's), lectronic stethoscope, interactive audio-visual capability	Diagnosis and consultatio therapy, specialists cons Lab tests, in-hospital pa observation, prescriptio record transmission, adm public health education, medical education, (emer consultation)
Lakeview Clinic (4-101ff, 220ff.) (3-22), (5-59) (13) Minnesota	HEW	Semi-rural	Not operational	Cable, portable video-carts, black and white, electronic stethoscope, interactive audio-visual capability	Diagnosis and consultatio therapy, specialist cons In-hospital patient moni
Mt. Sinai (4-119ff.) (3-22) (5-75ff.) New York	HEW	Urban	Not operational	Cable, black and white, electronic stethoscope, interactive audio-visual capability	Diagnosis and consultati therapy, specialist con public health education, education
Bethany/ Garfield (4-69ff.) (3-21) (5-21ff.) Illinois	HEW	Urban	Will be terminated shortly	Picturephone, cable, video-discs, black and white, interactive audio-visual capability	Diagnosis and consultati therapy, specialist con lab tests, prescription transmission, supervisio pharmacist technician

TABLE I
TELEMEDICINE PROJECTS

Location	Operational Status	Technology	Services
Urban	Bedford still operational Logan operational to a minimal extent	Microwave, cable, black and white, telemetry (ECG's, EEG's), lectronic stethoscope, interactive audio-visual capability	Diagnosis and consultation, therapy, specialists consultation, Lab tests, in-hospital patient observation, prescription and record transmission, administration public health education, continuing medical education, (emergency consultation)
Semi-rural	Not operational	Cable, portable video-carts, black and white, electronic stethoscope, interactive audio-visual capability	Diagnosis and consultation, therapy, specialist consultation, In-hospital patient monitoring
Urban	Not operational	Cable, black and white, electronic stethoscope, interactive audio-visual capability	Diagnosis and consultation, therapy, specialist consultation public health education, medical education
Urban	Will be terminated shortly	Picturephone, cable, video-discs, black and white, interactive audio-visual capability	Diagnosis and consultation, therapy, specialist consultation lab tests, prescription and record transmission, supervision of pharmacist technician

TABLE I
TELEMEDICINE PROJECTS

Experiments	Funded by	Location	Operational Status	Technology	Services
Case Western (4-69ff.) (3-21ff.) (5-53ff.) Ohio	HEW	Urban	Operational	Laser, cable, one-way color, one-way black and white, remote controls, interactive audio-visual capability, data transmission	Diagnosis and consultat specialist consultation patient monitoring, pre or record transmission, of nurse anesthetists, care monitoring, newbor observation, (training)
Illinois Mental Health (4ff, 218ff) (3-21) (5-53ff.)	HEW	Urban	Not Operational	Picturephone	Diagnosis and consultat therapy, administration education
Cambridge (4-76ff., 212ff.) (3-21ff.) (5-31ff.)	HEW	Urban	Not Operational	Microwave, black and white interactive audio-visual capability	Diagnosis and consultat therapy
Vermont/New Hampshire INTERACT (4-129ff., 235ff.) (3-21ff.) (5-87ff.)	HEW	Rural	Operational	Microwave, telemetry, one way color, one way black and white, interactive audio-visual capability	Diagnosis and consultat therapy, specialist con in-hospital patient obs public health education education
Blue Hill, Maine (4-73ff., 211) (6)	Maine Regional Medical Program	Rural	Operational	Microwave, black and white, interactive audio-visual capability	Diagnosis and consultat therapy, administration health education, super

TABLE I
TELEMEDICINE PROJECTS

	Funded by	Location	Operational Status	Technology	Services
ff.)	HEW	Urban	Operational	Laser, cable, one-way color, one-way black and white, remote controls, interactive audio-visual capability, data transmission	Diagnosis and consultation specialist consultation: in-hospital patient monitoring, prescription or record transmission, supervision of nurse anesthetists, intensive care monitoring, newborn nursing observation, (training)
tal ff.)	HEW	Urban	Not Operational	Picturephone	Diagnosis and consultation, therapy, administration, medical education
	HEW	Urban	Not Operational	Microwave, black and white interactive audio-visual capability	Diagnosis and consultation, therapy
	HEW	Rural	Operational	Microwave, telemetry, one way color, one way black and white, interactive audio-visual capability	Diagnosis and consultation therapy, specialist consultation, in-hospital patient observation, public health education, medical education
.,	Maine Regional Medical Program	Rural	Operational	Microwave, black and white, interactive audio-visual capability	Diagnosis and consultation, therapy, administration, public health education, supervision

TABLE I
TELEMEDICINE PROJECTS

Experiments	Funded by	Location	Operational Status	Technology	Services
Rural Health Associates (4-135ff., 240ff.) (7) Maine	OEO/HEW	Rural	Operational	Microwave, black and white, interactive audio-visual capability	Diagnosis and consultat therapy, lab tests, ra administration, superv
STARPAHC (4-150_ (13) Arizona	NASA Lockheed HEW	Rural	Operational	Microwave, land/mobile units, interactive audio-visual capability, computer data link	Diagnosis and consultat therapy, specialists c lab tests, radiology, and record transmissio tion, medical educatio
Alaska ATS (4-149) (10-2ff.) (13)	NASA/HEW	Rural	Not Operational	ATS-6, ATS-1 satellites, interactive audio-visual capability (4 sites), one-way video/two-way audio (1 site), black and white	Diagnosis and consultat administration, public education, medical educ supervision (emergency
Miami-Dade (4-144ff.) (8) (9) (19) Florida	NSF	Urban	Not Operational (Research experiments completed) Evaluation still being conducted	Slow-Scan, electronic stethoscope; microwave black and white; microwave-color; interactive audio-visual capability	Diagnosis and consultat therapy, prescription transmission supervisio
Ohio Valley (4-145ff.) (14)	ARC	Rural	Operational	Microwave, color interactive audio-visual two-way capability (3 sites), audio-visual one-way (1 site)	Diagnosis and consultat education, training, s conferences

TABLE I
TELEMEDICINE PROJECTS

nded by	Location	Operational Status	Technology	Services
/HEW	Rural	Operational	Microwave, black and white, interactive audio-visual capability	Diagnosis and consultation, therapy, lab tests, radiology, administration, supervision
A kheed	Rural	Operational	Microwave, land/mobile units, interactive audio-visual capability, computer data link	Diagnosis and consultation, therapy, specialists consultation, lab tests, radiology, prescription and record transmission, administration, medical education
A/HEW	Rural	Not Operational	ATS-6, ATS-1 satellites, interactive audio-visual capability (4 sites), one-way video/two-way audio (1 site), black and white	Diagnosis and consultation, administration, public health education, medical education, supervision (emergency care)
	Urban	Not Operational (Research experiments completed) Evaluation still being conducted	Slow-Scan, electronic stethoscope; microwave black and white; microwave-color; interactive audio-visual capability	Diagnosis and consultation, therapy, prescription and record transmission supervision
	Rural	Operational	Microwave, color interactive audio-visual two-way capability (3 sites), audio-visual one-way (1 site)	Diagnosis and consultation, education, training, supervision conferences

TABLE I
TELEMEDICINE PROJECTS

Experiments	Funded by	Location	Operational Status	Technology	Services
Boston City Hospital (11) (12)	NSF	Urban	Operational	Narrowband (augmented) facsmile	Diagnosis and consultati administration, speciali consultation, prescripti record transmission
Washington, Alaska, Montana, Idaho (WAMI) (4-149ff.) (10-2ff.) (13)	HEW	Rural	Not Operational	ATS-6, ATS-1, audio-visual capability interactive (2 sites), one way audio-visual capability	Medical education, diagnosis and consultati

TABLE I
TELEMEDICINE PROJECTS

Location	Operational Status	Technology	Services
Urban	Operational	Narrowband (augmented) facsmile	Diagnosis and consultation, administration, specialists consultation, prescription or record transmission
Rural	Not Operational	ATS-6, ATS-1, audio-visual capability interactive (2 sites), one way audio-visual capability	Medical education, diagnosis and consultation

the communications systems usually provided more than one of the five types of services and in some cases all five.

For the purposes of this study, there are basically three groups of questions to be answered with regard to the telemedicine experiments which have been conducted. These are:

- Was the technology adequate to provide the service? (Included in this question is the issue of whether the technology used is excessive -- e.g., were both audio and visual interaction necessary or would audio have been sufficient?)
- Were the services provided related to the needs of the population served?
- Were the economics of meeting health care needs by broadband communications considered? (This question includes not only the economic viability of the system but also analysis of the costs and benefits of meeting health care needs by some method other than broadband communications.)

To assist in considering these questions, Table 2 was prepared. It summarizes the objectives and results of the same sixteen experiments described in Table 1. The last column (labelled Comments) provides additional information on the issues raised above.

TABLE II
TELEMEDICINE PROJECTS

Project	Objectives	Results	Comments
Massachusetts General, Logan Airport Bedford, Veterans Administration Hospital (4-108ff.) (205ff.)	To determine clinical applications of technologies; to determine manpower/technology combinations; to develop ways in which provider /consumers can adapt to technologies; to develop cost-effective models.	Project proved technical feasibility and clinical applications; records showed health care provided was of sufficient quality. System at Logan was not cost-effective partially because of the presence of physicians at Airport site and because system was not fully utilized. High level of patient acceptance, provider acceptance was also apparent.	Systems have not been used to a extent. Some problem with tech systems due to atmospheric cond or human error. *These two projects are placed because they are connected to a link (Mass. Gen.). The Logan Ai link originated because the pri investigator initially saw the of the technology for providin medical care to accident victi Bedford link was initially est to provide specialty consultat (psychiatric and neurological) which is a long term health ca (4-25ff.)
Lakeview Clinic (4-101ff, 220ff.) (3-22)(5-59)(13)	To test clinical applications of technology in consultation, emergency care, patient monitoring; to determine provider/consumer attitudes; to determine technical benefits (save time, etc.) and feasibility in contrast to telephone; to determine if physician availability is increased; to determine if more personal relationships are established.	Easier access to consulting physician; patient anxiety reduced; more continuity in care, greater understanding of diagnosis and treatment. Consumer attitudes favorable; technical system provided versatility; physician practice did not increase; system made specialist more available.	Peak utilization was less than not used to full capacity; leg did not arise. Technical probl availability, set-up time, rel operational complexity, and ma No significant economic advant for physician. Security and co of patients did not arise as a however doctors used telephone confidential situations.

TABLE II

TELEMEDICINE PROJECTS

ves	Results	Comments
inical applications ; to determine logy combinations; in which provider dapt to technolo- cost-effective	Project proved technical feasibility and clinical applications; records showed health care provided was of sufficient quality. System at Logan was not cost-effective partially because of the presence of physicians at Airport site and because system was not fully utilized. High level of patient acceptance, provider acceptance was also apparent.	Systems have not been used to a maximum extent. Some problem with technical systems due to atmospheric conditions or human error. *These two projects are placed together because they are connected to a central link (Mass. Gen.). The Logan Airport link originated because the principal investigator initially saw the potential of the technology for providing emergency medical care to accident victims. The Bedford link was initially established to provide specialty consultation (psychiatric and neurological) to Bedford which is a long term health care facility (4-25ff.)
applications consultation, patient etermine r attitudes; hnical ime, etc.) in contrast determine if bility is termine if lationships	Easier access to consulting physician; patient anxiety reduced; more continuity in care, greater understanding of diagnosis and treatment. Consumer attitudes favorable; technical system provided versatility; physician practice did not increase; system made specialist more available.	Peak utilization was less than 2%, system not used to full capacity; legal issues did not arise. Technical problems with availability, set-up time, reliability, operational complexity, and maintenance. No significant economic advantages seen for physician. Security and confidentiality of patients did not arise as an issue, however doctors used telephone for most confidential situations.

TABLE II
TELEMEDICINE PROJECTS

Project	Objectives	Results	Comments
Mt. Sinai (4-119ff.) (3-22) (5-75ff.)	To determine patient/provider acceptance of technology; to determine effectiveness of system for health care delivery in lieu of "in-person" contact; to determine cost-benefit.	The system allowed for availability of specialists when there had previously been none; expanded role of mid-level practitioner; allowed for improved emergency care; reduced physician time; cost-effectiveness was identified as slightly lower than direct patient care.	Some technical difficulties audio-video quality due to studio conditions; difficul facsimile reproductions; so time"; some technical probl to human error.
Bethany/ Garfield (4-69ff.) (3-21) (5-21ff.)	To assess impact of technology on basis of contributions to health care and costs.	System demonstrated more rapid access to geographically dispersed internal resources; demonstrated technical feasibility; high acceptance by provider; allowed greater utilization of specialist services; greater use in emergency care.	Picturephone designed for f face communication and prov inadequate for document tra Picturephones relocated dur project to reflect increase of developers on need. Pro originally used broadband, discontinued after brief pe
Case Western (4-69ff.) (3-21ff.) (5-39ff.)	To evaluate viability of using two-way broadband audio-visual and data communications to remedy shortage and maldistribution of anesthesiologists; to determine manpower/technology combinations; to determine if quality health care could be provided.	Demonstrated effectiveness and viability of using technology for providing improved health service in anesthesiology; demonstrated effectiveness of supervision of mid-level practitioners by specialists; provided better emergency care; provided consultation where it wasn't previously available; provided training; and generated closer teamwork.	Mid-level prefer direct con cost systems not identified procedural problems such as scheduling and simultaneous monitoring have not been re This system has expanded to connections with a communit in a low-income area. Char the training of personnel hospital and the quality o have resulted.

TABLE II
TELEMEDICINE PROJECTS

Objectives	Results	Comments
determine patient/provider eptance of technology; to ermine effectiveness of tem for health care delivery lieu of "in-person" contact; determine cost-benefit.	The system allowed for availability of specialists when there had previously been none; expanded role of mid-level practitioner; allowed for improved emergency care; reduced physician time; cost-effectiveness was identified as slightly lower than direct patient care.	Some technical difficulties with audio-video quality due to poor studio conditions; difficulty with facsimile reproductions; some "down time"; some technical problems due to human error.
assess impact of tech- ogy on basis of tributions to health care costs.	System demonstrated more rapid access to geographically dispersed internal resources; demonstrated technical feasibility; high acceptance by provider; allowed greater utilization of specialist services; greater use in emergency care.	Picturephone designed for face to face communication and proved inadequate for document transmission. Picturephones relocated during project to reflect increased knowledge of developers on need. Project originally used broadband, but was discontinued after brief period.
evaluate viability of using -way broadband audio-visual data communications to edy shortage and mal- tribution of anesthesio- ists; to determine power/technology combinations; etermine if quality health could be provided.	Demonstrated effectiveness and viability of using technology for providing improved health service in anesthesiology; demonstrated effectiveness of supervision of mid-level practitioners by specialists; provided better emergency care; provided consultation where it wasn't previously available; provided training; and generated closer teamwork.	Mid-level prefer direct contact; cost systems not identified; some procedural problems such as scheduling and simultaneous monitoring have not been resolved. This system has expanded to include connections with a community-hospital in a low-income area. Changes in the training of personnel for that hospital and the quality of care have resulted.

TABLE II
TELEMEDICINE PROJECTS

Project	Objectives	Results	Comments
Illinois Mental Health (4-92ff. 218ff.) (3-21) (5-39ff.)	To determine the extent to which the technology could enhance mental health delivery; to determine specific applications of technology.	System increased communication and information exchange of providers; diminished need for patient/provider travel.	Problem occurred with instal systems in most effective si technical deficiency for tra financial and medical data. lack of effective planning a subsequent reorganization of nology to better sites, firm conclusions on video benefit could not be made.
Cambridge (4-76ff. 212ff.) (3-31ff.) (5-31ff.)	To test manpower/technology combinations; to test consultative applications and to determine if there would be reduction of referrals and improvement in quality of treatment; to test consumer/provider acceptance. Project compared telephone and television consultations.	Project demonstrated similar referral rates for TV and telephone although consultation time was substantially longer for television, in part, due to set up time and also because TV tended to enrich personal contact; demonstrated good technical quality; increased amount of information available; provided on-going education. Physicians had major problems due to location of technology.	Problems with accessibility consulting rooms for physic rigidity of experimental des System was not utilized to f extent.
Vermont/ New Hampshire INTERACT (4-129ff., 235ff.) (3-21ff.) (5-87ff.)	To explore technical feasibility and provider/consumer acceptance of speech therapy and dermatology delivered via technology.	Speech therapy was highly accepted by provider and consumer; provided means for training mid-level persons; increased usage of referral services; provided services not otherwise available; promoted inter-staff communications; reduced transportation time/costs; use of color for dermatology not significant.	Minimal technical problems. therapy now self-supporting, personnel are now trying to ways to make system cost-ef

TABLE II
TELEMEDICINE PROJECTS

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ower/technology ; to test applications mine if there uction of re- improvement f treatment; umer/provider Project com- one and onsultations.	Project demonstrated similar referral rates for TV and telephone although consultation time was substantially longer for television, in part, due to set up time and also because TV tended to enrich personal contact; demonstrated good technical quality; increased amount of information available; provided on-going education. Physicians had major problems due to location of technology.	Problems with accessibility of video consulting rooms for physician, rigidity of experimental design. System was not utilized to full extent.
echnical and provider/ eptance of py and delivered via	Speech therapy was highly accepted by provider and consumer; provided means for training mid-level persons; increased usage of referral services; provided services not otherwise available; promoted inter-staff communications; reduced transportation time/costs; use of color for dermatology not significant.	Minimal technical problems. Speech therapy now self-supporting. Project personnel are now trying to determine ways to make system cost-effective.

TABLE II
TELEMEDICINE PROJECTS

Project	Objectives	Results	Comments
Blue Hill Maine (4-73ff,211) (6)	To use technology as the mechanism for providing mid-level practitioner with necessary support thereby enabling her to provide primary health care to island population. Based on community needs.	System gave nurse practitioner assistance in emergency care, consultation over primary health care problems. Showed the validity of using mid-level practitioner to provide primary health care.	Because the mid-level pract only haelth care provider o land, system proved useful. of using system originated island built a clinic but c keep a physician. The Proj tor stated that the system coordinated with an institu Community now paying for gr of system's usage.
Rural Health Assoc. (4-135ff., 240ff.) (7)	To establish a comprehensive health care delivery system to serve West Central Maine by developing a group practice of doctors and mid-level practitioners; to provide and increase health care for a dispersed population; to find payment mechanisms for low-income families and to determine if prepayment for health care in rural areas is a viable mechanism. Based on community needs.	RHA used technology as a mechanism for providing service. Project proved the validity of using mid-level practitioners for health care delivery. Feasibility of using the technical system was demonstrated although questions regarding its necessity remain. Technical systems were exceptional for peer-group interaction among health care providers and for administrative functions. Also the intangible benefits of the doctor-patient/doctor-practitioner relationships appear positive, though not adequately evaluated. Satellite clinics have to be partially subsidized by main clinics.	Project based on health nee community. Technical proble to poor system planning and stallation; some problems a to weather conditions. The overcome. The technology w a primary purpose of the pr
STARPAHC (4-150) (13) (17-3)	To provide data for developing health care for future manned spacecraft by testing physician/paramedic link; testing technology; identifying technology advancement needs areas; improving the delivery of health care to remote areas.	Data has not yet been obtained.	

TABLE II
TELEMEDICINE PROJECTS

Objectives	Results	Comments
e technology as the nism for providing mid- practitioner with sary support thereby ing her to provide ry health care to d population. on community needs.	System gave nurse practitioner assistance in emergency care, consultation over primary health care problems. Showed the validity of using mid-level practitioner to provide primary health care.	Because the mid-level practitioner was only haelth care provider on the island, system proved useful. The idea of using system originated because island built a clinic but could not keep a physician. The Project Director stated that the system had to be coordinated with an institution. Community now paying for great portion of system's usage.
ablish a comprehensive care delivery system ve West Central Maine eloping a group practice tors and mid-level tioners; to provide and se health care for a sed population; to find t mechanisms for low- families and to ine if prepayment for care in rural areas iable mechanism. on community needs.	RHA used technology as a mechanism for providing service. Project proved the validity of using mid-level practitioners for health care delivery. Feasibility of using the technical system was demonstrated although questions regarding its necessity remain. Technical systems were exceptional for peer-group interaction among health care providers and for administrative functions. Also the intangible benefits of the doctor-patient/doctor-practitioner relationships appear positive, though not adequately evaluated. Satellite clinics have to be partially subsidized by main clinics.	Project based on health needs of community. Technical problems due to poor system planning and installation; some problems also due to weather conditions. These were overcome. The technology was not a primary purpose of the project.
vide data for developing care for future manned raft by testing physician/ ic link; testing technology; fying technology advancement reas; improving the delivery th care to remote areas.	Data has not yet been obtained.	

TABLE II
TELEMEDICINE PROJECTS

Project	Objectives	Results	Comments
Alaska ATS-6 (4-149) (10-2ff.) (13)(18)	To explore the potential of satellite video consultation to improve health care to a highly remote area, to provide education and training to health care providers to the public; to provide health information system; to determine feasibility of using health care proivders (mid-level) for health delivery to rural areas.	Satellite communication can reliably provide signals of sufficient quality to be useful for health service delivery for rural areas; useful consultations for a variety of medical problems could be conducted; satellite video consultation can be successfully carried out by health care providers at all levels of training; the unique features of video transmission may be critical in 5 to 10% of cases selected for video transmission, otherwise there is little measurable difference between audio vs. video consultation; Health care providers involved felt video consultations improved health care system capability, but questioned whether it was worth the costs - providers placed stronger emphasis on audio as mandatory for health care delivery in rural areas.	Experiment designed as a mean potentially reducing rural hea delivery problems;- some sites in experiments were inaccessible by land, and had audio communication prior to satellite.
Miami Dade (4-144ff.) (8)(9)(19-143ff.)	The objective of the telemedicine phase was to determine cost/benefits of telemedicine using nurse practitioners; to gather data on the relative merits of different types of video communications which can be used in telemedicine systems. [The total project (Phase I and II) looked at organizational structure of delivery systems, manpower possibilities, and technologies as a part of health care delivery systems.]	There was no difference in quality of care given by on-site physicians compared to care given over telemedicine. Nurse primary practitioners provided medical care equal to that of physicians. Telemedicine links not cost-effective when compared to cost of care administered by nurse practitioner; telemedicine was equal in cost to care provided by on-site physician.	Research experiments are comp evaluation of project is sti conducted. This experiment w conducted in two stages: base introduced medical record sy extensive use of nurse pract and telemedicine which intro technology. Principal invest stated that telemedicine may cost effective in settings w transportation is a major pr where costs of physician tim are equivalent to those of ph in nonacademic settings. The used in this experiment were academic environments and as have generally lower salarie

TABLE II
TELEMEDICINE PROJECTS

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re the potential of e video consultation to health care to a highly rea, to provide n and training to health viders to the public; de health information to determine feasibility health care proivders el) for health to rural areas.	Satellite communication can reliably provide signals of sufficient quality to be useful for health service delivery for rural areas; useful consultations for a variety of medical problems could be conducted; satellite video consultation can be successfully carried out by health care providers at all levels of training; the unique features of video transmission may be critical in 5 to 10% of cases selected for video transmission, otherwise there is little measurable difference between audio vs. video consultation; Health care providers involved felt video consultations improved health care system capability, but questioned whether it was worth the costs - providers placed stronger emphasis on audio as mandatory for health care delivery in rural areas.	Experiment designed as a means for potentially reducing rural health delivery problems;- some sites in experiments were almost inaccessible by land, and had no audio communication prior to satellite.
ctive of the tele- phase was to determine efits of telemedicine rse practitioners; r data on the relative f different types of mmunications which can in telemedicine systems. l project (Phase I looked at organi- structure of systems, manpower ities, and tech- as a part of health ivery systems.]	There was no difference in quality of care given by on-site physicians compared to care given over telemedicine. Nurse primary practitioners provided medical care equal to that of physicians. Telemedicine links not cost-effective when compared to cost of care administered by nurse practitioner; telemedicine was equal in cost to care provided by on-site physician.	Research experiments are completed; evaluation of project is still being conducted. This experiment was conducted in two stages: baseline which introduced medical record system and extensive use of nurse practitioners; and telemedicine which introduced technology. Principal investigators have stated that telemedicine may prove cost effective in settings where transportation is a major problem, and where costs of physician time are equivalent to those of physicians in nonacademic settings. The physicians used in this experiment were from academic environments and as such, have generally lower salaries.

TABLE II
TELEMEDICINE PROJECTS

Project	Objectives	Results	Comments
Ohio Valley (4-145ff.) (14)	To use technology for providing primary health care and diagnosis.	Evaluation and results not yet available because of relative newness of the system.	System became operational Project was not developed System has been used more cation/grand rounds and me conferences.
Boston City Hospital (11) (12)	To demonstrate and test feasibility of using distributed health and delivery system for nursing home populations by using nurse practitioners; to test quality of care rendered by NP's; and to determine comparative costs, benefits of NP vs. traditional physician visits system.	Use of NP's proved beneficial. 80% of NP work did not require physician consult; frequency of care was better than traditional system; quality of care slightly better than traditional system.	Project is being continued demonstration (telephone a facsimile equipment) was n purpose. Technologies wer because they were inexpens provided necessary backup Key factor of any health c using technology is the fu organization of the people in financing Medicare thro to state law.
Washington, Alaska, Montana, Idaho (WAMI) (4-149ff.) (10-2ff.) (13)	To demonstrate feasibility of satellite technology as a support for program in decentralized medical education.	Experiment demonstrated the feasibility of using satellite for teaching, administration, and patient care. Broadened potential of medical education alternatives for relieving maldistribution and shortage of physicians for rural areas.	This project was originall to provide a new system of education to three states could not build a medical When satellite became avai was used to increase abili to provide educational ser Some malfunctions in techn occurred due to design fla rangement of equipment, we conditions.

TABLE II
TELEMEDICINE PROJECTS

tives	Results	Comments
nology for rimary health agnosis.	Evaluation and results not yet available because of relative newness of the system.	System became operational in 1975. Project was not developed as intended. System has been used more for education/grand rounds and medical conferences.
ate and test of using dis- alth and delivery nursing home by using nurse rs; to test care rendered d to determine costs, benefits raditional phy- ts system.	Use of NP's proved beneficial. 80% of NP work did not require physician consult; frequency of care was better than traditional system; quality of care slightly better than traditional system.	Project is being continued. Technology demonstration (telephone and some facsimile equipment) was not a purpose. Technologies were chosen because they were inexpensive and provided necessary backup to NP. Key factor of any health care system using technology is the function and organization of the people. Problem in financing Medicare through NP due to state law.
ate feasibility e technology as or program in ed medical	Experiment demonstrated the feasibility of using satellite for teaching, administration, and patient care. Broadened potential of medical education alternatives for relieving maldistribution and shortage of physicians for rural areas.	This project was originally designed to provide a new system of medical education to three states who did not/could not build a medical school. When satellite became available it was used to increase ability of system to provide educational service. Some malfunctions in technology occurred due to design flaws, arrangement of equipment, weather conditions.

Adequacy of technology. A useful framework for reviewing developments in telemedicine over the last decade is that proposed by Bashshur.[1] He divides the development of telemedicine in the U.S. into three stages:

- 1964-1969: experimental efforts by independent medical practitioners to test the applicability of the technology to clinical needs. The general objective during this period was testing the feasibility of two-way communications for diagnosis and clinical use (20-6).

- 1969-1973: continuation of the first stage but with Federal support for research and development in telemedicine (20-3). HEW, NSF, OEO and NASA participated in programs to establish the technical capability of communications techniques for various clinical uses (20-6).

- 1973- present: treatment of telemedicine as a method for delivering health care. Program objectives shifted to assessing whether telemedicine could be self-supporting or economically viable and to assessing the quality of care relative to other methods (20-4).

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[1] Bashshur, Rashid and Armstrong, Patricia. "A Review of Telemedicine as a New Mode for the Delivery of Health Care." (In press: quoted with permission of Inquiry.)

As can be seen in Tables I and II, telemedicine experiments have largely been concerned with testing the technology and clinical applications using the technologies. Most experiments were initiated during one or the other of the first two stages. However several experiments implemented during the third stage described by Bashshur, have been designed to address questions of economic viability and the adequacy of health care provided by various technology/manpower combination alternatives (Boston City Hospital and Miami-Dade projects). In addition, subsequent evaluations of several projects conducted in the first and second stages of telemedicine have shown important findings regarding economic viability and alternative technology/manpower combinations.

As is apparent from Table II, a variety of technical problems were encountered during the telemedicine experiments; however, most of these problems were overcome. Such difficulties included large amounts of "down time" when systems were not operational; noise interference with the use of certain equipment; and difficulties in focusing and placing the cameras. In addition, adverse weather conditions affected the operation of equipment in certain locations, and lack of an adequate power source held up usage in some instances. Nevertheless, most technical difficulties and problems were solved in the course of the experiments. In general, it can be said that (20-11):

> "By the end of the second stage, the capabilities of telemedicine equipment had advanced to a level where technological difficulties were no longer an important determinant in its effectiveness, and initial observations about the clinical applicability of telecommunications to specified diagnostic problems were made" (20-11).

Although technical feasibility was demonstrated, an important issue raised by telemedicine experiments is the level of technology necessary to meet health care requirements. In other words, while two-way interaction is clearly required for most functions in health care delivery, are both audio (voice and data) and visual interaction necessary, or is audio sufficient?[1] The question is important because audio-only systems are less expensive and can be served by conventional telephone rather than more expensive technologies.

One study evaluating the manpower/technology combinations for rural health care delivery systems states that an augmented narrow-band network used to link professional with mid-level practitioners is a viable means for providing effective health services to rural populations (74). Concurrently, the Boston City Hospital Nursing Home project also demonstrated the feasibility and value of using augmented narrowband technologies for providing health care.

In contrast, other telemedicine experiments using broadband technologies have shown advantages of the visual modes provided by such technologies. A specific experiment funded by the Department of Health, Education and Welfare (Cambridge Hospital Project) tested two-way audio-visual vs. standard telephone for consultation between three low-income neighborhood health stations and the Cambridge Hospital (5-31 ff.). The health service stations were staffed by nurses who consulted with physicians at the hospital using the two different techniques. It was found that:

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[1] Considering the increased capability of telephone lines for transmitting data, it has been suggested that more creative use of telephone systems ("augmented narrowband") may be an option for use in health care delivery systems.

> "there were significant referral pattern differences between television and telephone. This is of key importance in the rural setting where the economic, physical, and emotional penalty suffered by the consumer may be lessened with the utilization of television. Regarding the desirability of the two, both consumers and providers (physicians and nurse practitioners) expressed a slightly higher degree of satisfaction for television than telephone consultations" (5-32).

Also of significance is the fact that the television consultations took longer than the telephone consultations and that more information was transferred using television. As a result, "more than twice as many telephone consultations resulted in immediate hospital referral than with television. The television made it possible to handle a significantly greater proportion of the referrals to physicians entirely within the neighborhood health center, by reducing the need for immediate referrals to the hospital" (5-37). This is of critical significance to rural applications where access to hospitals may be difficult and the economic penalty of hospitalization tends to be greater than for the average urban resident because of lower average income levels and lower rates of health insurance.

To summarize, the technical feasibility of using broadband or augmented narrowband communications technologies to provide health services has been demonstrated. With the telemedicine experience of the last ten years, technical problems have been resolved. As regards audiovisual vs. voice only, what now needs to be provided is hard and more detailed data on the value of adding the visual mode. Bashshur points out that:

> "To obtain quantified answers concerning the visual contribution to specific benefits and problems in terms of the quality of care, access, and cost of health care delivery systems will require additional well-focused research" (5-7).

Relationship between the experiments conducted and rural needs. This is the second question raised earlier. There are at least four aspects to be considered. One is the degree to which telemedicine can serve the range of rural health needs identified at the beginning of the Chapter. A second is the adequacy of health care provided. A third is the acceptability of telemedicine to both patient and the health care professionals. Finally, one may ask whether telemedicine experiments have been based upon an analysis of the particular needs of a given rural area which might be best served by telecommunications.

As previously indicated, telemedicine experiments have been successfully conducted in various aspects of each of the five categories of health services identified by Rockoff (3-22). Telemedicine has been successfully used for consultation, supervision, direct patient care, administration and management, and education and training. It appears that telemedicine has the potential for contributing to each of the four areas of specific rural needs identified at the beginning of this Chapter. This is because of the demonstrated feasibility of using midlevel practitioners for primary health care. Thus, by linking a nurse-practitioner or physician-assistant in remote areas to physicians and specialists, telemedicine can help fill the need for increased primary health and specialist care. One exception is that dental service experiments appear not to have been done. (However, it is possible to visualize diagnostic dental service via telemedicine.)

Generally, telemedicine can increase accessibility of rural residents to health care personnel and reduce the need for travel to remote hospitals and clinics unless such travel is necessary. Similarly, telemedicine can increase access to emergency medical services. It can also provide for continuing education of remote health personnel, reduce feelings of isolation and provide access for medical peer consultation and referrals. Thus, telemedicine could help attract or retain medical personnel in rural areas. Coupled with the stated preference of the majority of the population at large (which presumably includes some medical personnel) for nonurban living as described in Chapter III, telemedicine could be a significant inducement to medical personnel to locate in rural areas. Unfortunately, data from rural telemedicine experiments are not adequate to evaluate this potential.

Experiments have demonstrated that telemedicine can increase the adequacy of health care by providing access to services to underserved populations which were not available before or were only available to a minimal extent. Significant data on this point comes from the seven exploratory two-way audiovisual telemedicine projects supported by the Department of Health, Education, and Welfare beginning in 1972 (these are experiments 2-8 listed in Tables I and II). The projects took place in both rural and urban settings and involved a variety of health care services. As stated in a review of the benefits and problems associated with the seven experiments:

> "...New services were provided to the patient by the telemedicine system that were not available before its introduction. Patients accept the recommendations of their doctors and rely on their judgment. As such, no appreciable patient dissatisfaction with telemedicine care was detected or registered. It would appear that from all projects the patient received increased quality of care in one form or another (e.g., received emergency treatment sooner, received physician supervision of non-physician, and received specialist consultation where it wasn't available previously)" (5-19).

Aside from quality of care, acceptability of telemedicine by both patients and health care personnel are important facts to be known. As indicated in the last quote, patients appear to find telemedicine acceptable. There also seems to be a change in attitudes before and after exposure to telemedicine. Just one exposure to telemedicine appears to bring about this change in attitude. Data on this point were collected by survey in the Rural Health Associates project. Even those exposed to telemedicine for the first time seemed quite satisfied as shown below:

> "When asked, 'compared to seeing a doctor in person, how satisfactory did you find seeing a doctor over TV?' about seven in every ten (71%) checked that it was the 'same as seeing a doctor in person'. Only about one in six (16%) thought it less satisfactory than seeing a doctor in his office. It will be remembered that over four out of every five (78%) of the general population, almost all of whom had not received any medical care over TV, felt that seeing a doctor over TV would be less satisfactory than seeing him in person. What is more, although only about a third (32%), of the persons who had not received medical care over TV thought that it would be about as easy or more easy to explain medical problems over TV, about four in every five (79%) of those who had received TV care indicated they found that it was 'no different', that it was about as easy to explain their medical problems over TV as it was in person"[1] (21-8).

Patient acceptability of telemedicine is further shown by data from the same project when patients were asked whether they would rather wait to see a doctor in person rather than having more rapid access through TV. Thus:

> "The fact that these persons have had pleasant medical experiences over TV probably explains why almost four in every five (75%) felt that they would rather wait only one day for an appointment to see a doctor on TV than to wait either three days to see a doctor in person or two days for an appointment to see a nurse-practitioner or physician-assistant."[1] (21-10).

The three quotes above suggest that patient acceptability to telemedicine is high and that positive benefits in the way of access to increased health services accrue. In addition, patients appear to have minimal problems with the equipment (5-19).

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[1] Weeks, H. Ashley, "Changing Attitudes toward Telemedicine". Preliminary Survey results presented in paper at the Second Telemedicine Workshop, Tucson, Arizona, December 4-6, 1975. (Unpublished, quoted with permission.)

While health professional note benefits associated with telemedicine (such as increased access to patients, reduction of the need for their physical presence, consultative support, etc.) they also cite problems. For physicians, privacy, confidentiality and other legal issues were raised in nearly all seven of the HEW project (5-8; 5-18). Ease of access to television facilities is also an important aspect of physician acceptance. For nonphysician medical personnel, many favored direct face-to-face interaction. There is also a "Big Brother" syndrome associated with a physician monitoring a nurse or physician assistant via TV. However, these problems were generally overcome. Proper location of television facilities is also important in facilitating acceptance among nonphysician medical personnel (5-18).

Thus, acceptance of telemedicine on the part of health care personnel is somewhat less than for patients. Another problem relates to the resolution of legal issues. Aside from general issues of privacy and confidentiality, some laws will require change if maximum benefits are to accrue from telemedicine. An example is drawn from the Bethany-Garfield experiment (see Tables 1 and 2):

> "...the State of Illinois requires one pharmacist to personally supervise one pharmacist assistant. When considering the shortage of pharmacists and evening and weekend coverage requirements, the one-to-one state requirement and personal supervision are formidable obstacles in a community hospital complex such as Bethany-Garfield, which would like to use its Picturephone system to supervise apprentices by remote control" (5-8).

A second legal issue arises from Medicaid reimbursement. As far as is known, it has not been established that reimbursement can be made under the circumstances surrounding health care provided by telemedicine. Also to be considered uncertain and open to further analysis is the degree to which the experiments have been based upon actual needs analysis and detailed attention to those needs which could be best met by telecommunications. In general, this level of sophistication of application is only beginning to be addressed. However, in both the Blue Hill and Rural Health Associates projects, the central purpose of the experiments was providing care to meet the health needs of the communities served.

Economic considerations. Turning to the economics of meeting health care needs by broadband communications, two aspects must be considered: 1) the economic viability of the service; and 2) the costs and benefits associated with use of telemedicine vs. some other method. These are issues which fall into Bashshur's third stage in the development of telemedicine; concern with questions of this sort date from about 1973. Several recent evaluations of telemedicine experiments have been designed to determine the costs and benefits of using different technologies and manpower combinations. One cost analysis study suggested that field trials should be directed to use voice and data transmission without video. However, it should be noted that the authors of that study also state that "consideration of alternative technologies from the standpoint of the patient may point to broadband" (i.e., video as well as voice) (22-87). Several studies which have evaluated costs of telemedicine have generally found that the costs of using such systems with mid-level practitioners are marginally lower than the costs of having a physicians services (Miami-Dade and Mt. Sinai projects). However, others feel that the case for telemedicine has yet to be proved in view of the short periods of time over which most research and demonstration programs are conducted. Thus, "none of the programs operated optimally at peak patient loads to warrant a true test of cost effectiveness (20-11).

The difficulty of drawing conclusions from government field trials conducted to date has been considered by Elton. As summarized by Bashshur (20-11), Elton, identified two major problems:

> "(1) the length of time involved in these projects and (2) the problem of uncertainty. Field trials are conducted for a specified period of time-- usually one to two years. Hence, the time constraints tend to influence the course of the trial, that is, the results may or may not occur when the time constraint is absent. A program could be termed unsuccessful when the actual problem may have been lack of an appropriate time period to develop the program. Field trials are set up to reduce uncertainty by developing and conducting a program and then evaluating it. The problem is that the evaluation is tacked onto the trial rather than included as an intregral stage during the process of the trial. Thus, the issues to be evaluated are not clearly separated, and it is difficult to determine exactly what issues are being effected, and in turn are effecting the outcomes. The trial often is not successful in reducing uncertainty, or does so only partially. Elton suggested that the field trial is a necessary form of research, but, to be meaningful, the evaluation process must be clearly defined for the field trial."

Rockoff clearly states the need for additional data:

> "Although the exploratory experiments have yielded 'clinical impressions' about areas where this technology (i.e., visual telecommunications) is likely to be quite beneficial, such as scheduled specialty teleclinics, careful research and experimentation will be required to clarify and quantify the benefits and the associate costs in order for health-care system planners to have the information they need to decide on visual telecommunication in the face of the other options available" (3-28).

Potential rural applications. A review of the experience with telemedicine has shown that meeting many rural health needs by broadband communications is technically feasible. In addition, patient acceptance of telemedicine is high and the potential of broadband communications to improve quality of care by increasing patient access to services previously unavailable to them has been demonstrated. While ensuring privacy and confidentiality remain problems for physicians, these have not prevented application of telemedicine so far. However, broader application will probably require resolution of these issues. In addition, some laws constrain reaching the full potential of broadband communications for improving health care. As for nurse-practitioners and physician assistants, benefits in terms of access of consultation have been demonstrated but there have been some problems such as a feeling of too close supervision. These have generally been overcome.

While the use of telemedicine has been demonstrated in a number of experiments, many demonstrations have not been economically viable and have been discontinued when Federal funds were no longer available. In part, this may be based on lack of adequate needs analysis of the particular community before the project was undertaken. An interesting exception is the Blue Hill project, which was specifically oriented to meeting health care needs of the community. The isolated community of Deer Isle first attempted to attract and retain a doctor with a community clinic. When this failed, attention was turned to telemedicine with a midlevel practitioner and microwave connection to the Blue Hill Memorial Hospital. This proved successful. While the project has been supported by the Maine Regional Medical Program, community support is now the primary financial base for the system (6).

While telemedicine appears to be a feasible way to bring health care to rural areas, data are inadequate to assess its value and benefits in cost-effectiveness terms. However, for rural applications in particular, cost-effectiveness may not be the only criterion. This is because alternatives to telemedicine are limited or perhaps even nonexistent in some rural areas. For example, one alternative is to build more hospitals. However, this alternative has already tried and rejected. "Small hospitals of 50 beds of less were built in rural areas under the Hill-Burton Program to provide specialized services to rural physicians. However, this program has been discontinued because the facilities have proven to be uneconomical in operation and the volume of work has not permitted adequate quality control of professional activities or laboratory studies" (Harrell in 23-14). As another example, if physicians find remote areas unattractive, the alternative of improving health care by increasing the health manpower in the area is not likely to be successful. Thus, telemedicine could be the only alternative for improving health care in some areas. Paradoxically, by enabling physicians to consult with their peers, have access to specialists, and continue their education, telemedicine could also remove many of the reasons physicians do not locate in rural areas. Thus, a redistribution of health manpower could occur just because of the solution imposed to meet a manpower shortage. This, however, remains speculative at the present time.

As a further note on costs, it seems unrealistic to suggest that a broadband system would be built solely for its use in providing health services. Others have noted that to encourage telemedicine system to become "self-supporting", sharing of communications links with other social services should be considered (20-17) and some calculations have even been made on the effects of cost-sharing in which 50% of broadband system costs are picked up by other services (23-16). However, if a broadband system is viewed as a means for making a variety of services, including subscriber-supported entertainment, available to a community, telemedicine might be required to support considerably less than 50% of system cost. This approach is pursued further in Chapter IV.

In summary, it appears that there is considerable potential for telemedicine to contribute to rural health needs. Lack of adequate data on value and costs suggests the need for further study. However, it is suggested that the keynote for such study should be evaluation of economic viability. An approach is outlined in Chapter IV of this report.

Education

Equal access to education has been a goal in the United States for the past two decades. However, statistics on educational resources and grades of education completed suggest that rural residents are at a disadvantage with regard to educational opportunities compared to their urban counterparts. This section examines rural education needs, experimental efforts to provide education via broadband communications and the potential of broadband communications to supply educational services to rural areas.

Rural needs. Opportunity for education depends upon adequacy of educational resources and services at each level of education sought (primary school through adult education), and accessibility to these services by students. Unfortunately, lack of data limits the following analysis to a description of general differences in nonmetro as compared to metro areas. Further, as discussed in the next Chapter, rural areas differ significantly from each other in population and socioeconomic characteristics. Thus, while some aggregate differences between metro and non-metro areas can be shown, the characteristics of particular rural areas may differ from the general description provided here.

Major factors which influence quality and access to rural education are:

- economic characteristics of the community; and
- organizational structure of educational systems.

The importance of economic characteristics lies in the fact that major financial support for education comes from the local community. In 1971-1972, on a national basis, financial support for public elementary and secondary schools were derived from the following sources (24-47):

- 53% from local funds;
- 38% from state funds; and,
- 9% from Federal funds.

Analysis of financial resources for rural areas showed that, in 1973, 45% of the revenue for local school systems in nonmetropolitan areas was from property taxes (25).

Concerning the availability of financial resources, rural communities generally are found to have lower per capita income and a greater percentage of people living below the poverty level. In 1974, the Census Bureau reported that the median income for metropolitan residents was $12,844 compared to $10,327 for nonmetropolitan residents (26-98). In addition, 9.7% of metropolitan populations were below the poverty level compared to 14% of nonmetroplitan populations (26-16). Although the median income and poverty level of nonmetropolitan areas varies greatly among states, the statistics indicate that rural populations generally have a smaller economic base for tax revenues. The significance of the reduced economic base for nonmetro areas is that educational resources are likely to suffer. Educational programs will be more limited, facilities and equipment will be reduced and teachers will receive lower salaries and possibly have lower qualifications than in urban areas.

In addition to the funds available for rural education, the organizational structure of educational systems also influences the quality and accessibility of rural education. By organizational structure is meant the degree to which schools are consolidated, which is reflected in the number of one-teacher schools and the number of pupils enrolled in each school. Previously many rural populations had one-teacher schools as the main education resource in the community. In 1960 there were 40,500 school districts and 20,000 one-teacher schools within those school districts. Considerable consolidation occurred in subsequent years and in 1974 there were approximately 16,700 school districts and 1,365 one-teacher schools. Of the 16,700 school districts, 16,300 were operating schools within their districts and the other 300 were providing for their students by other means, i.e., transferring them to nearby operating districts (27-6; 28-53). Consolidation increases the enrollment in each school which in turn influences the services and resources for a given school system. However, 4,723 school systems in this country (28.9% of the total) have enrollments of fewer than 300 students (24-55). These may be compared to a HEW Report which concluded that "a system should serve at least 500 students in order to offer what is now considered a full program" (24-55).

In considering the densities and distribution of rural populations, it appears that many of the schools with fewer than 300 pupils are located in rural areas. Consolidation of school systems can increase the diversity of educational programs by reducing per pupil costs. According to one report "the most important single factor causing high per pupil costs in rural schools is a relatively high ratio of professionals to students" (29-2).

While consolidation of schools has aided in alleviating costs incurred by high teacher-student ratios, in some rural areas it may have increased the financial burden of transporting students greater distances. According to Thomas, "on the average, school districts in rural areas pay high per pupil costs for transportation. A large proportion of pupils in rural areas are transported, and costs per pupil mile are also relatively high... where state aid does not cover the full costs of transportation, rural school districts must pay the difference in costs from funds that would otherwise be available for instruction" (29-6).

In light of the population density and distribution, the economics of rural populations, the financial resources for rural education and the organizational structure of school systems, it appears that many rural communities have fewer economic resources available to finance their educational systems, reduced accessibility of schools to students and teachers, and a need for a wider array of educational services than are presently provided. While consolidation and financial reform in education may be steps toward resolving the problem or providing equal educational opportunity, the economic and demographic characteristics of rural areas today still hinder the abilility of rural communities to deliver quality education which is both accessible and cost-effective.

Another indication of equality of educational opportunity is the enrollment of students at different levels of education. Relevant data are:

- proportionately fewer nonmetro residents attend institutions for higher learning. For those 18 to 34 years old, 17% of metro residents were enrolled in colleges compared to 11% for nonmetro residents

- the Department of Health, Education and Welfare estimates that about 54 million adults have not received a high school diploma (33). Of adults over age 25, 13.9% from nonmetro areas received no more than an eighth grade education compared to 10.1% from metro areas (26-10).

- particularly startling are the differences in participation in adult education courses. Of the 822,000 participants in federally sponsored adult education courses, only 13% of those enrolled lived in nonmetro areas (31-7).

The above data indicate that nonmetro residents receive less education than their metro counterparts. Exact reasons are unclear. On the one hand, it may be hypothesized that educational opportunities are there but simply are not used. On the other hand, it may be hypothesized that the lower quality of and/or reduced access to educational resources accounts for the lower educational levels achieved by rural residents. Support for the latter hypothesis is provided by a 1969 survey of 32,000 Appalachian teachers. This survey of a predominantly rural area indicated that teachers in locations with few inhabitants generally had less opportunity for in-service training, received smaller salaries and were teaching in schools with less than adequate facilities (32).

In summary, although direct data are sparse, it appears that rural areas are not equal to metro areas in educational opportunity. The following appear to be the major areas of need:

- greater diversity of educational programs including improved resources and services;
- increased accessibility to education;
- increased opportunities for adult education; and
- increased opportunities for continuing education of rural teachers.

The following discussion covers communications experiments in education and the potential for broadband communications to meet rural education needs.

Experiments. Table 3 summarizes ten experiments using two-way communications techniques for educational purposes. (It should be noted that there have been many one-way applications, including conventional educational television. These are not considered here.) The funding sources, location of the experiment (urban or rural), operational status, technology used and services provided are indicated.

Several comparisons can be made between the education experiments and those which have been conducted in health (Table 1). As in health, the major funding source for education experiments has been the Department of Health, Education and Welfare. Fewer experiments have been conducted in education than in health. Only one semirural and three rural education applications were found. The technology used in the educational

TABLE III

EDUCATION PROJECTS

Experiments	Funded By	Location	Operational Status	Technology	Services
"Cable Television Project" Tulsa School Systems (34) Oklahoma	Tulsa School System	Urban	Operational	Cable; color one-way audio-visual capability, one-way visual with two-way audio-capability; two-way audio-visual. System interconnects four schools with Educational Center at school system administration offices.	Provided a number of c to elementary and seco students, some of whic previously available. teachers and students tunity to plan and pro tional programs. Prov vice training and conf between school admisis and teachers.
Program for Homebound Handicapped Amherst, N.Y. (35) (36) (40)	Bureau of Education for the Handicapped (funding for two years at totals $738,404) Expected to secure funds from other sources once BEH grants have expired However, Federal funds end in FY 75. Whether other sources will be found is questionable.	Urban	Operational	Cable used to transmit time-shared, interactive computer controlled information television (TICCIT); - the TICCIT systems modifies material for television format. Interactive digital response unit.	Currently provides 26 students with individu instruction. Schedule serve up to 100 studen provides for library r

TABLE III

EDUCATION PROJECTS

By	Location	Operational Status	Technology	Services
School	Urban	Operational	Cable; color one-way audio-visual capability, one-way visual with two-way audio-capability; two-way audio-visual. System interconnects four schools with Educational Center at school system administration offices.	Provided a number of courses to elementary and secondary students, some of which were not previously available. Provided teachers and students with opportunity to plan and produce educational programs. Provided in-service training and conferences between school admisistrators and teachers.
of ion for ndicap- unding years ls 04) ed to funds her once nts pired , Fed.- nds end 5. other will be s nable.	Urban	Operational	Cable used to transmit time-shared, interactive computer controlled information television (TICCIT); - the TICCIT systems modifies material for television format. Interactive digital response unit.	Currently provides 26 homebound students with individualized instruction. Scheduled to serve up to 100 students. System provides for library requests.

TABLE III

EDUCATION PROJECTS

Experiments	Funded By	Location	Operational Status	Technology	Services
Handicapped Project University of Kentucky (35) (38)	Bureau of Education for the Handicapped funding for two years, total = $286,965	Urban All BEH projects expected to secure funds from other sources once BEH grants have expired However, Federal funds end in FY 75. Whether other sources will be found is questionable	Operational	Telephone lines used to send computer signals to homes with individualized teaching units; two-way audio; tactile response capability	Provide specialized/ education to 18 home tally retarded child years old) with zero skills
Handicapped Project New York (35) (38)	Bureau of Education for the Handicapped funded for two years Total = $598,240	Urban	Operational	Cable television used to transmit instructional programming, video-taped programs and computerized programs; digital response unit.	Provides specialized for handicapped stud five community cente
Appalachian Education Satellite Project (41-106 ff.)	HEW HEW funded programs NASA satellite Satellite in India; no money to continue.	Rural	Not Operational	ATS-6, ATS-3 satellites black and white, ground receiving units-telephone transmission for some ground functions; one-way audio-visual capability, two-way audio capability Also used computers for information storage and retrieval.	Provided graduate (c education) courses d in career education tary reading for rur provided in-service career education and during academic year video software for p can be reused elsew 1200 teachers initia

TABLE III

EDUCATION PROJECTS

	Location	Operational Status	Technology	Services
for capped or two tal =	Urban	Operational All BEH projects expected to secure funds from other sources once BEH grants have expired However, Federal funds end in FY 75. Whether other sources will be found is questionable	Telephone lines used to send computer signals to homes with individualized teaching units; two-way audio; tactile response capability	Provide specialized/individual education to 18 homebound mentally retarded children (0-6 years old) with zero behavior skills
for capped r two l =	Urban	Operational	Cable television used to transmit instructional programming, video-taped programs and computerized programs; digital response unit.	Provides specialized instruction for handicapped students at five community centers.
ASA in	Rural	Not Operational	ATS-6, ATS-3 satellites black and white, ground receiving units-telephone transmission for some ground functions; one-way audio-visual capability, two-way audio capability Also used computers for information storage and retrieval.	Provided graduate (continuing education) courses during summer in career education and elementary reading for rural teachers; provided in-service training in career education and reading during academic year; produced video software for programs which can be reused elsewhere; serve 1200 teachers initially.

TABLE III

EDUCATION PROJECTS

Experiments	Funded By	Location	Operational Status	Technology	Services
Federation of Rocky Mountain States Satellite (40-100 ff.) (43-21)	HEW (Educational Programming portion) NASA (satellite) $11,000,000 rough cost to HEW: $11 million	Rural	Not Operational	ATS-6, ATS-3, one-way video; two-way audio capability cable, translators	Provided career educa courses to junior hig in 56 rural communiti vided materials distr systems for teachers; continuing education for adults on topics health care, problems land use, etc. Provid in-service training.
Tager System (2-43) (42) Texas	Private philanthropy provided some original funding for technology. Annual operating budget $225,000 schools and institutions support system through enrollments.	Urban	Operational	Microwave; one way video, two-way audio capability; black and white.	Provides 70-80 three hour graduate and und courses to students a universities and eigh dustrial firms.

TABLE III

EDUCATION PROJECTS

	Location	Operational Status	Technology	Services
e) ugh $11	Rural	Not Operational	ATS-6, ATS-3, one-way video; two-way audio capability cable, translators	Provided career education courses to junior high students in 56 rural communities; provided materials distribution systems for teachers; provided continuing education courses for adults on topics such as health care, problems of aging, land use, etc. Provided teacher in-service training.
s s ents.	Urban	Operational	Microwave; one way video, two-way audio capability; black and white.	Provides 70-80 three credit hour graduate and undergraduate courses to students at nine universities and eight industrial firms.

TABLE III

EDUCATION PROJECTS

Experiments	Funded By	Location	Operational Status	Technology	Services
Northern Virginia Community College and Manicopa County Community College (Phoenix) (40)	NSF	Urban	Operational	TICCIT (Time shared, Interactive Computer-Controlled Information Television)	Provides courses in composition and mat to community colleg
Spartanburg, South Carolina (44,45,46, 47, 48)	NSF ($1,106,566)	Urban	Operational	Cable. Adult education; one-way video with push-button response. Daycare education: two-way audio-visual.	Adult education. T daycare personnel. noneducational serv
Alaska ATS Experiment	HEW: (education programs) and receiving stations NASA: (Satellite)	Rural	Not Operational	ATS-6, ATS-1; two-way audio, one-way video	Programs broadcast communities in inst basic oral language health, education, service training; c information broadca

TABLE III

EDUCATION PROJECTS

unded By	Location	Operational Status	Technology	Services
NSF	Urban	Operational	TICCIT (Time shared, Interactive Computer-Controlled Information Television)	Provides courses in English composition and mathematics to community college students.
F 1,106,566)	Urban	Operational	Cable. Adult education; one-way video with push-button response. Daycare education: two-way audio-visual.	Adult education. Training of daycare personnel. (Also other noneducational services.)
W: ducation ograms) receiving tions ASA: tellite)	Rural	Not Operational	ATS-6, ATS-1; two-way audio, one-way video	Programs broadcast to 17 remote communities in instruction of basic oral language development, health, education, and in-service training; community information broadcasts

applications was more diverse with various combinations of cable, translators, satellite, microwave and computers. It will be noted that two-way capability was generally more limited than in the health applications discussed earlier (where both audio and visual modes were typically available in both directions). In the education experiments, transmission typically involved both audio and visual, but response was generally limited to voice and/or data (e.g., digital response by pushbutton). This difference in response mode derives from the nature of the use made of communications for education: typically teaching of courses to a group of students. Whether such teaching is done by a teacher or by a computer, the responses required can be accomplished with voice or pushbuttons. For some purposes, pushbutton responses are more useful than voice. This is because digital responses can be analyzed for a group of students as they occur permitting the teacher to keep track of student understanding as material is presented.

A further difference between health and education is that more progress has been made in applying communication technologies to health needs than to educational needs. As has been shown the technical feasibility of using communications to meet a variety of health care needs has been demonstrated and experimental efforts are now moving into such areas as the best ways of combining manpower and technology into total health care delivery systems, with increasing emphasis being laid on cost-effectiveness studies.

By comparison, educational efforts appear to be less well-organized, with less clearcut objectives and with more work needed on how best to use available technology for educational purposes. However, there does seem to be increasing recognition of these deficiencies and efforts are underway to remedy them. Noteworthy in this connection are the plans and studies of the Rehabilitation Services Administration (RSA) of the Department of Health, Education and Welfare, which should go far to consolidate findings and provide a structure for vocational rehabilitation and education uses of communications. Current RSA efforts include assessment of available software and hardware; assessment of legislative, regulatory and attitudinal aspects of using communications technology for education; and methods for coordinating programs between RSA agencies (49).

Potential rural applications. To assist in considering potential rural applications Table 4 was prepared. It summarizes the objectives and results of the educational experiments listed in Table 3.

Though some problems have occurred (such as adverse effects from weather conditions in the Alaskan satellite experiment), the technical feasibility of using broadband communications to meet rural education needs has been demonstrated. Thus, the ATS satellite experiments have demonstrated that broadband communications can be used to increase the diversity of and access to educational programs, increase opportunities for adult/community education and provide in-service teacher training. However, a number of areas require further work.

First, the effectiveness of the technology as a tool for improving the quality of education remains to be demonstrated. It is unclear whether students learn as much over television with response capabilities as they do in a classroom, and the way to maximize the effectiveness of communications techniques for education remains to be worked out. Evaluation programs should be an integral part of future experimental efforts.

TABLE IV
EDUCATION PROJECTS

Project	Objectives	Results	Comments
Tulsa School Systems (34)	Phase I & II designed to demonstrate feasibility of using technical systems with different capabilities; to determine educational applications and student reaction; to learn whether students would interact over systems; to demonstrate that supplementary enrichment, not previously available, could be provided; to test feasibility of expanding computer-assisted instruction.	Feasibility of technology was adequately demonstrated, but some problems still need correction. New courses were provided, two-way interactive transmissions were generally preferred. Other potential uses for system were recognized particularly administrative, community outreach, adult education, special education, security, staff development.	Project has been conducte ent phases with different It was designed to be use uously. Technical proble visual imagery and sound Idea for project originat channels donated by Tulsa vision as a part of fulfi regulations. Project ori planned to also aid in im relations and was a part school intregration plan. cannot be expanded to oth due to lack of funds for installation.
Amherst, New York (35,36,40)	To demonstrate the effectiveness of computer-based instruction delivered via closed-circuit television to severely multi-handicapped students, to demonstrate use in metropolitan areas with already established cable television capabilities.	Evaluation and results are not yet available, however results will be based on frequency of use. System appears to have a positive impact on families as well as students.	Project now operational. problems have occured. S not yet been used to full although it has component mine the extent to which be used. No cost analysi into original plans, alth personnel are working on involved agency and hosp rals of students.
University of Kentucky (35,37)	To develop an electronically programmed environment for preschool children with severe mental retardation and attendant multiple handicaps.	Evaluation and results are not yet available since project is still in operational phase.	Project now operational. system is a modified vers clinical physhology. Sys for highly individualized as well as analysis of re the end of each teaching No cost analysis included

TABLE IV
EDUCATION PROJECTS

jectives	Results	Comments
II designed to demon- sibility of nical systems rent capabilities; ne educational ns and student to learn whether ould interact ms; to demon- t supplementary , not previously could be provided; asibility of ex- mputer-assisted n.	Feasibility of technology was adequately demonstrated, but some problems still need correction. New courses were provided, two-way interactive transmissions were generally preferred. Other potential uses for system were recognized particularly administrative, community outreach, adult education, special education, security, staff development.	Project has been conducted in different phases with different objectives. It was designed to be used continuously. Technical problems with visual imagery and sound occurred. Idea for project originated in Tulsa; channels donated by Tulsa cable television as a part of fulfilling FCC regulations. Project originally planned to also aid in improving race/relations and was a part of Tulsa's school intregration plan. Services cannot be expanded to other schools due to lack of funds for equipment installation.
rate the effec- f computer-based n delivered via cuit television y multi-handi- dents, to demon- in metropolitan already estab- le television es.	Evaluation and results are not yet available, however results will be based on frequency of use. System appears to have a positive impact on families as well as students.	Project now operational. Technical problems have occured. System has not yet been used to full capacity although it has component to determine the extent to which it will be used. No cost analysis written into original plans, although project personnel are working on it. Planning involved agency and hospital referrals of students.
an electronically environment for children with severe ardation and atten- ple handicaps.	Evaluation and results are not yet available since project is still in operational phase.	Project now operational. Computer system is a modified version of the clinical physhology. System allows for highly individualized instruction, as well as analysis of responses at the end of each teaching session. No cost analysis included.

TABLE IV
EDUCATION PROJECTS

Project	Objectives	Results	Comments
New York City (35, 38)	To determine how and the extent to which telecommunications can aid in the development of severely emotionally disturbed children; to develop learning modules and to test technology feasibility.	Evaluation of results not currently available because program is still operational. One major thrust of the program has been to develop the software (educational) programs for handicapped. Evaluation will look at student progress.	Some technical problems occurred (i.e., digital response units not stro enough to handle studen major motor skills hand Cost analysis was not i in project.
Appalachian Education Satellite Project (39,41-106 ff.)	The educational objectives were to improve the effectiveness of classroom teacher by upgrading skills in career education and reading.	Generally viewed as successful project. Explored and demonstrated feasibility of using satellites to link up with terrestrial sites to provide educational programs; demonstrated positive response of participants; used trans-state structure to deliver educational services; developed procedures for software development; demonstrated feasibility of central computer system for information delivery via satellite	Conducted needs analysi planning phase in order mine greatest needs; te problems were minimal. of courses via satellit satellite costs, appears tially cost effective; understanding of rural problems evolved.
Satellite Project Federation of Rocky Mountain States (41-100 ff.) (43-21)	To demonstrate feasibility of using satellite technology for delivery of educational services to rural areas; to test and evaluate user acceptance and the cost of various delivery modes.		Minimal technical probl covered four year perio planning implementation from 1971-1975. Based system's potential user were numerous problems flicts in federal, regi and local objectives.

TABLE IV
EDUCATION PROJECTS

Objectives	Results	Comments
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ucational objectives were rove the effectiveness of oom teacher by upgrading in career education and .	Generally viewed as successful project. Explored and demonstrated feasibility of using satellites to link up with terrestrial sites to provide educational programs; demonstrated positive response of participants; used trans-state structure to deliver educational services; developed procedures for software development; demonstrated feasibility of central computer system for information delivery via satellite	Conducted needs analysis in planning phase in order to determine greatest needs; technical problems were minimal. Delivery of courses via satellite excluding satellite costs, appears to be potentially cost effective; greater understanding of rural education problems evolved.
nstrate feasibility g satellite techno- r delivery of edu- l services to rural to test and evaluate ceptance and the cost ous delivery modes.		Minimal technical problems. Project covered four year period including planning implementation, evaluation from 1971-1975. Based on needs of system's potential users. There were numerous problems with conflicts in federal, regional, state and local objectives.

TABLE IV
EDUCATION PROJECTS

Project	Objectives	Results	Comments
Tager System (2,42)	To provide courses needed by educational institutions and industry by sharing resources and using technology.	Highly successful; technology used extensively; students do not hesitate to use interactive audio capability; 99% efficiency in the technology (Industry does not originate courses)	System has been operati since 1966. TAGER was established as intercon and sharing of resource institutions. Sponsori cipants realized that could save time and mak more accessible; system self-supporting, flexib allows versatility and in educational policy f cipating schools and in System designed to be u continuously.
Northern Virginia Community College and Maricopa County Community College (Phoenix) (40)	To determine if computer assisted instruction (CAI) could be made a more viable, cost-effective method of instruction to test the value of instruction provided by computer technology.	Evaluation not yet available.	Prior to TICCIT, comput instruction had been us adjunct to traditional instruction. This proj aimed at determining th tiveness of using compu the main form of instru proctor and/or teacher The technology systems 99% reliability. Accep has generally been good evaluations are still

TABLE IV
EDUCATION PROJECTS

jectives	Results	Comments
ide courses needed tional institutions stry by sharing s and using tech-	Highly successful; technology used extensively; students do not hesitate to use interactive audio capability; 99% efficiency in the technology (Industry does not originate courses)	System has been operational since 1966. TAGER was originally established as interconnection and sharing of resources among institutions. Sponsoring participants realized that technology could save time and make courses more accessible; system is now self-supporting, flexible and allows versatility and freedom in educational policy for participating schools and industries; System designed to be used continuously.
mine if assisted ion (CAI) made a more cost-effec- hod of ion to test e of in- n provided ter technology.	Evaluation not yet available.	Prior to TICCIT, computer assisted instruction had been used as an adjunct to traditional classroom instruction. This project is aimed at determining the effectiveness of using computers as the main form of instruction with proctor and/or teacher support. The technology systems has proved 99% reliability. Acceptance has generally been good although evaluations are still underway.

TABLE IV
EDUCATION PROJECTS

Project	Objectives	Results	Comments
Spartanburg, South Carolina (44,45,46,47,48)	To test the use of broadband communications to provide adult education, training of day care personnel and other noneducational public services; careful evaluation of broadband compared to alternatives; cost-benefit analyses.	Not yet available	Selection of public servic the experiments was based careful analysis of commun and consideration of how b communications could help needs.
Alaska ATS Experiment (41)	To explore uses of technology for providing educational instruction to highly remote populations of Eskimos, Indians, etc. to assess program effectiveness and acceptance; and, to determine the value of operational techniques		Based on need, Services w to teachers, citizens and in very remote regions wh inaccessible; language ba sent problems to students are isolated.

TABLE IV
EDUCATION PROJECTS

bjectives	Results	Comments
the use of broadband ations to provide lucation, training are personnel and neducational public ; careful evalu- broadband compared natives; cost-benefit .	Not yet available	Selection of public services for the experiments was based on a careful analysis of community needs and consideration of how broadband communications could help meet these needs.
re uses of technology iding educational in- n to highly remote pop- of Eskimos, Indians, assess program ef- ss and acceptance; and, ine the value of al techniques		Based on need, Services were provided to teachers, citizens and students in very remote regions which are often inaccessible; language barriers present problems to students, teachers are isolated.

A related problem is the need for a data bank on educational programs or at least guidelines on how to effectively use interactive communications techniques for educational purposes. This would assist rural communities wishing to use broadband techniques for educational purposes to make effective use of them.

A third area of concern is the need for cost-effectiveness data. Some cost data were developed for the Appalachian experiments. Additional analyses are anticipated from the Spartanburg experiments (see also Chapter IV for discussion of the Spartanburg project). However, the Spartanburg project is located in an urban setting.

Overall, it seems that inadequate consideration has been given to the economic viability of education uses of broadband communications. Further attention is given to this topic in Chapter IV.

Law Enforcement

Rural needs. Rural area law enforcement authorities face similar problems and utilize similar operating procedures to those found in large municipalities. Many of the same administrative procedures are in use. Police officers attend roll calls and training sessions, and receive much of the same kind of administrative information, including wanted and missing persons circulars. They are also expected to prepare, submit and receive similar forms and reports.[1]

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[1] Interviews with Captain William McCaa, Communications Department, Boulder County Sheriff's Department, Boulder, Colorado, and A. J. Anderson, Division of Communications, State of Colorado, Denver, Colorado. Although the analysis in this section is based upon rural law enforcement operations in the State of Colorado, these operations vary sufficiently in different parts of Colorado as to provide a broad sampling of conditions of operation.

A major difference between rural and urban law enforcement officers is the distance separating the officer from the central station. The rural officer must travel long distances just to interact with fellow officers, attend training sessions, and/or process arrested persons. As a result, he is away from his patrol area for long periods of time. It has been reported that in one area of Colorado, police officers typically spent up to one-quarter of their working time traveling to and from the central station.

The larger distances in rural areas have forced law enforcement officers to rely more heavily on telecommunications. Present day telecommunication networks in county sheriff departments now range from complex integrated systems employing leased telephone lines, multi-channel radio and microwave links down to simple single channel radio systems. These networks provide communications with the central station, sub-stations, vehicles, and individual officers at home or in the field. They further provide intercommunication, through the central station, with city police in counties with large municipalities, with state police and investigative agencies, and with fire and medical units.

Concerning the needs of rural law enforcement authorities, it is clear that communications are already being used extensively to overcome problems caused by distance. The issue thus seems to be whether cable might be a lower cost alternative to such means as microwave and leased telephone lines, or whether cable might offer features not now available that could further reduce unproductive travel time.

As one example, it has been estimated that the use of cable is generally less costly than microwave for distances up to 10 miles (50-95). Over 10 miles, it might be possible in some instances for law enforcement departments to install dedicated microwave links or share existing microwave links between town clusters in rural broadband systems.

Anticipating the next section's discussion of the Philadelphia Police Department's use of broadband communications, it has been demonstrated that broadband can be effectively used for televising roll calls and briefing sessions, transmitting fingerprints and other related documents and conducting administrative pre-trial arraignments. Whether volume or present travel costs might make the widespread provision of those services by broadband economically attractive will depend upon the charcteristics of the individual rural area in question.

Experiments. In the terminology used in this Chapter, home burglar alarm services -- on the assumption that they are not likely to be paid for by the local government -- are included in a later section under commercial applications. Because programs designed to educate the public in such subjects as self defense and crime prevention are not revenue-generating, they also are not covered.

According to a recent NSF survey, only three tests of law enforcement broadband applications have been conducted in recent years. None could be classified as experiments in the conventional sense, and two of these, now discontinued, involved only the use of closed circuit for simple surveillance purposes (1-33).

The third of these, involving the conversion to broadband delivery of a number of important functions at a major U.S. police department (Philadelphia, Pennsylvania), stands alone in terms of magnitude and significance.

The Philadelphia system is comprised of two coaxial cables each with a capacity of 64 channels. One cable is being used for downstream service, the other for upstream. When the system is completed in the spring of 1976, it will connect the city hall, main police headquarters, nine division headquarters, and 22 district stations at an overall estimated cost of approximately $3.5 million (51).

The project began in 1969 with a study conducted by the Franklin Institute Research Laboratories. The objectives were to:

1) determine what police communications functions could be better and more economically performed on closed circuit television;

2) establish an appropriate systems configuration; and

3) develop and install a pilot system to demonstrate the capabilities of cable television to perform the tasks assigned (51).

The Franklin Institute study not only determined that existing communications functions could be done more economically, it also identified a number of new procedures which are now in the process of being implemented. The functions involved, together with the benefits anticipated through the use of broadband, are as follows:

FUNCTION	BENEFIT
1. Video conference calls between high-level police personnel.	Elimination of travel time to some meetings, more frequent and effective communication resulting in better understanding, unity, and smoother operation.
2. Television addresses to policemen at roll call by top command.	Better understanding of policies and situations at all levels, improved morale.
3. Dissemination of television training material to the divisions served.	Reminders to policemen of safety, legal and administrative procedures, etc.

4.	Facsimile transmission of messages and bulletins between the Police Administration Building (PAB) and divisions served.	Faster and more economical dissemination of written and photographic material.
5.	Van mobile unit with microwave permitting recording and monitoring special events throughout the City.	Provides concrete evidence of events for police or court review and a limited means for police to centrally monitor live certain events of a highly critical nature.
6.	Decentralized photographing and fingerprinting of arrestees with transmission of fingerprint images by high-resolution facsimile.	Expedite the identification process, reduce crowding at the PAB.
7.	Release-on-own-recognizance interviews and preliminary arraignments conducted over closed circuit television between divisions and PAB.	Eliminate the need to transport prisoners to the PAB (thereby saving time and money and reducing the chance of prisoner escape) and reduce the time an arrestee is detained unless he is committed to jail.

Other future possible functions for the system, listed briefly, include videotaping and transmitting lineups, regular live monitoring of special events throughout the City, monitoring traffic, surveillance of potential trouble spots (business districts and stores), and making videotapes of arrestees for an identification record (52-7).

The major monetary savings estimated at this time are related to the elimination of the need for transporting arrestees from the nine division headquarters to the main headquarters for fingerprinting and preliminary arraignment procedures.[1] At the present time, that step, which requires one wagon and two officers in each instance, is estimated to cost $750,000 a year. Other advantages anticipated are: decentralization of the arresting process and allowing the person to be arraigned in his own neighborhood; reduction in backlog; and freeing-up of police officers for other duties (53-4).

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[1] These procedures have raised legal and other objections. The public defender originally contended that the required "in-person appearance before a judge" was not being met by the use of cable TV (51). The promise of a reduction in process time helped to overcome this objection. The use of a telephone overcame the second objection of not being able to talk to the defendant in person privately. The other objection from the public defender's office dealt with the less personal nature of television. Civil rights group have objected to the use of TV for surveillance, citing possible invasion of privacy. Problems dealing with bail, e.g., the desirability of having the divisional or district police stations collecting money, have been resolved by allowing persons paying bail to pay at police headquarters, following which release documents are transmitted to the division stations by facsimile (56).

Potential rural applications. At the time of this writing, no funding source had been located by the Philadelphia Police Department to conduct a cost-effectiveness study of the conversion of the described functions to broadband delivery (53). This is especially regrettable because this law enforcement application is the only one of its kind and conceivably might have a major effect in streamlining procedures and saving money in urban as well as rural departments. Without a cost-effectiveness study, there is no way of determining the net savings resulting from the use of the system or arrestee processing and pre-trial arraignment procedures; all that is known is that the previous procedures cost the Police Department $750,000 annually. There is also no hard data on the net savings that have resulted from the use of the system for training, teleconferencing, roll calls, facsimile transmission, and other functions described earlier. It might be noted that the Federal government, through the Law Enforcement Assistance Administration grant, already has a sizable stake in this project. The additional observation might be made that funding of a cost-effectivenss follow-up study could be relatively inexpensive compared to its potential worth in assessing the value of this unique effort and its possible use elsewhere.

Pending the availability of such information, this use of broadband can only be considered of potential application in rural areas. From what is known about the project generally, however, it might be one which could be profitably explored in connection with the suggested system demonstration program described in Chapter IV.

Governmental/Administrative Uses

One likely application of broadband systems is use by government in processing citizen claims and applications when more than one agency and more than one location is involved. Especially when the poor are involved, as in welfare applications, the costs to the government for transportation between agencies can be substantial. One experiment bearing upon this use of broadband communications was identified during the course of this survey. That experiment, involving inter-agency processing in Spartanburg, South Carolina, is discussed in Chapter IV.

Commercial Applications

There are four broad classes of auxiliary services which could utilize the capabilities of broadband communications systems and which have profit-making or commercial potential. These four classes are identified and briefly described below.

1) Security Systems. Included in this group are: 24-hour smoke and fire surveillance, intrusion surveillance, police call, medical request, and emergency alert services. These services are generally paid for by the home or business subscriber as part of, or in addition to, their standard cable television service.

2) Information Services. By information services is meant updated information-on-demand such as stock and commodity market reports, sports information, and educational information. A fee is charged for these services and paid by a home or business subscriber.

3) Data Transmission Services. These services are used where large amounts of information must be transferred among various offices. Potential users are banks, government agencies, and public utility companies. Dedicated channels leased by a business subscriber for computer-to-computer, computer-to-terminal or terminal-to-computer data communications are used to provide these services.

4) Pay-Television. Pay-TV provides entertainment services which subscribers are willing to pay for beyond the traditional network programming supplied to all subscribers. Services include: first run and other current movies, live sports events, live theatre, and other special events.

Each of the above classes of commercial and business services will be examined to give some insight into their current status and applicability to rural applications. As will be subsequently discussed in Chapter IV, these services are important in that they can be a source of revenue that can help defray the installation and operating costs of broadband systems. It is important to note that some of these types of service require that the system have bidirectional capability. This may rule out consideration of such services for the older established one-way systems generally found in rural towns. As a further note, since research in each of these areas is privately funded, it can be anticipated that in the future detailed cost and revenue information might not be available for competitive reasons. This could make it difficult to forecast their application in rural areas with any degree of precision.

Security Services

Financial losses from fires on farms rank with those from weather, plant and animal disease, and insects. In addition, recent crime statistics indicate that the unlawful entry in rural areas is increasing rapidly. This section provides some background on rural needs dealing with fire and crime problems, discusses how telecommunications systems are being used for fire and smoke detection and crime surveillance and outlines how such systems may be applicable to rural and farm communities.

Rural needs. Fire and lightning strike about two of every 100 farms each year. According to the Insurance Information Institute, fire losses on the nation's farms in 1970 were $242 million almost twice the $131 million loss estimated for 1950 (54). Losses are increasing at a rate of 10-12 percent per year. In 1971 the insurance premiums paid by farmers to cover fire and wind damage totaled $441 million (55). When fire occurs on rural property, damage is typically three to six times greater than on properties located in urban areas (56). Factors contributing to higher rural damages include the high value of major farms, isolation, lack of fire-fighting facilities and less rigid wiring, heating, and construction standards.

Up to now, minimizing losses from fires in rural communities where households are isolated from modern fire departments have depended on the following traditional approaches:

1) Preventing the fire in the first place by learning to recognize and correct potential fire hazards.

2) Constructing buildings so as to reduce the chances of a fire starting and spreading.

3) Training residents in fire fighting techniques to prevent the spread of fires once started.

Schools, fire departments and insurance companies are continually disseminating information to aid in identifying fire hazards. Newer rural buildings are being constructed to minimize fire hazards. Metal or asbestos roofing materials are being used instead of wood shingles; approved central heating systems are being installed in place of kerosene space heaters; and approved permanent electric wiring is being used instead of temporary, easily overloaded extensions. In open areas, farm buildings are being equipped with lightning rods to minimize lightning-caused fires. Fire extinguishers are now standard equipment in many rural homes and some homes are being equipped with smoke detectors. Volunteer fire departments are also better equipped and better trained. In spite of these efforts, however, fire is still a major concern in isolated rural areas, especially in older structures, and especially when the residents are away from their homes.

Concerning crime, one category in particular -- unlawful entry -- has been increasing in rural areas at a rate nearly double that in cities and four times that in Standard Metropolitan Statistical Areas.

Unlawful Entry Crime Rate (per 100,000 population)

	SMSA*	Other Cities	Rural
1970	1311	730	437
1973	1411	842	564
% Average Increase per year '70-'73	2.5	5.1	9.7

* SMSA - Standard Metropolitan Statistical Areas (54)

As to action being taken to combat crime, rural departments in recent years have received better equipment and training. In the section on public services the telecommunications capabilities of rural police authorities were discussed. Nonetheless, one of the weakest links in these systems continues to be the inability of the law officer to provide surveillance of isolated properties at sufficiently frequent intervals to deter unlawful entry.

Technologies presently exist which allow continuous monitoring of isolated buildings from central locations for both fire and crime detection. These technologies and their principal uses to date are described below.

Remote security monitoring. The burglar alarm industry has foreseen the need for providing continuous 24 hour security service. However, manual on-site surveillance costs have restricted the market to larger commercial and industrial clients.

It is now possible to provide security surveillance service over existing telephone lines, or through special leased lines which will function even if normal telephone service is interrupted. Installation charges using the existing telephone system are approximately $30 with a $2 per month charge for the required protective coupler. Special leased lines typically cost $6 per mile installed. Installation costs to residential subscribers are typically $300-500 for fire detection systems and $500 and higher for burglar alarm systems. Monthly fees are approximately $20-60 for each service (57). Household or business establishments can be surveyed from a central private station or from the local fire and/or police station. Systems are computerized and can provide an immediate printout of the location and time a problem has been detected.

At the beginning of this decade, many within the cable television industry actively considered using their systems for security services. It was anticipated that these services might have high potential for generating additional revenues. Services most discussed were home protection services such as smoke detection, heat sensing and intrusion (unlawful entry) detection. The systems were conceived as having a centrally located computer and a switching system capable of "polling" sensors in the subscriber households at regular intervals, usually in a matter of seconds.

In spite of this widespread industry interest, there apparently are only two firms active in the area of security services: TOCOM and Intech Laboratories. TOCOM, Inc., of Irving, Texas, has developed working and commercially available security systems. The firm is prepared to supply, operate, and maintain a complete system which is comprised of the following: central interrogator, memory bank, complete cable system, subscriber converters, subscriber-identified digital transmitters, smoke and fire dectectors, and manually operated police and/or medical call stations. The TOCOM systems also have the capacity to provide such optional services as perimeter intrusion detection (e.g., wired windows), pay television, opinion polling, and meter reading. The TOCOM system is made up to two sub-systems -- a central data system and a remote transceiver which is located at each of the subscriber households. The central data system controls the whole system, supervises overall communications and interprets information.[1] The remote transceiver performs the function of decoding communications information intended for that transceiver and executing subsequent commands as instructed by the central data system. The central data system and the transceivers are interconnected with a bidirectional cable network (58).

TOCOM's primary markets have been new communities where systems are installed during the construction phase. At the present time TOCOM is working with six communities, the largest being a projected 50,000 unit community called "The Woodlands" located 25 miles north of Houston. The company installs, operates, and maintains all parts of the cable system. Woodland CATV, Inc., a subsidiary of TOCOM, is paying for the cable distribution plant and the home builders are paying for the home wiring, including the installation of the security devices. Plant construction and wiring are both component costs at the Woodlands development. According to TOCOM officials, these costs are similar for all TOCOM systems (58).

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[1] Remote monitoring raises issues of privacy and confidentiality. For a discussion of these issues the reader is referred to Kay, Peg. Social Services and Cable TV. Final report submitted by the Cable Television Information Center to the National Science Foundation under contract No. APR 75-18714, February 1976.

TOCOM Systems Component Costs (in dollars)

Cable Distribution System	
Head-end plus central data system	$150,000-175,000
Distribution system per mile of cable	$5,000-10,000
Subscriber Location Costs	
Wiring (usually paid by builder)	$400-600
Two-way terminal (transceiver)	$250
Optional intrusion system (wired windows, etc.)	$150
Monthly Subscriber Fees	
CATV only	$7
CATV plus basic security services	$12

To date 97.7 percent of the 500 occupied homes in the Woodlands complex have elected to subscribe to the combined CATV/Security service. As an added incentive to encourage the homeowner to purchase the security services, a homeowner insurance policy premium discount of almost 20 percent is available to the two-way subscribers having a fire detector and a manually operated police call system. This discount, applied to the homeowner policy on a $30,000 frame home, is about five dollars per month; applied to a $65,000 brick veneer home, it is about nine dollars per month. An additional 10 percent discount, beyond the 20 percent described above, is provided to those homeowners who have the perimeter intrusion system. The system discussed has already demonstrated its effectiveness by averting actual fire damage in the home of one of the subscribers in the Woodlands area (58).

The other company which is currently active in the security systems field is Intech Laboratories, Inc., located in Ronkonkoma, New York. Intech is presently developing a system under contract to Manhattan Cable to be used in the Roosevelt Island Project in Manhattan. The system being developed will be a modification of their automatic multipoint CATV analyzer/monitor subsystem. The central processing unit will be capable of addressing and reading four sensors in each of 1000 apartments every second. The location of a trouble signal, along with any special instructions regarding the specific resident, will be printed out on a cathode ray tube terminal at a central guard station.

The cost to wire each apartment in the Roosevelt Island project will be approximately $150. The central processing unit is expected to cost $20,000. Manhattan Cable is installing the cable network during construction of the buildings.

Rural applications. Both telephone and cable television systems could be used for monitoring buildings in rural areas for fire and unlawful entry. Each system uses techniques and system components with basically similar functions. Each, however, has its own advantages or disadvantages depending on the characteristics of the specific area in which it is to be employed. Hybrid systems consisting of both telephone lines and cable are conceivable for servicing communities where households are separated by distances too great to justify a cable-only system.

Probably the greatest merit of remote surveillance of isolated rural buildings is that such surveillance can be done even while the residents are not on location. A second advantage is that non-residential buildings, such as barns, can be monitored even while the owners are asleep in their homes. An immediate phone call to a sleeping owner could be sufficient to prevent a fire from getting out of control.

While home terminal and operating costs for supplying security services would likely be paid for by the individual subscriber through monthly fees, it is possible that the central processing console and installation costs might be paid for in part by local law enforcement and fire fighting agencies. In light of the precedent set by the insurance company serving the Woodlands project discussed above, it should be noted that lower insurance premiums might offset a large part of the costs to the subscribers.

Concerning the economic feasibility of these services as provided by means of a rural broadband system, it is important to recognize that Woodland's costs to subscribers assume that the substantial costs entailed in wiring the homes ($400-600) are paid for by the builder. Whether these services might pay their own way and yield some net revenue to a broadband system in rural areas will depend upon this and many other variables which are beyond the purview of this study.

Information Services

Rural needs. Newspapers, news letters, business periodicals, and radio have long been used by rural residents to keep abreast of day-to-day fluctuations in the stock markets and commodities exchanges, as well as for business and other professional information. The paper media, although not suitable for constant updating of information, have had the advantage of being able to provide such information in very detailed form. The much faster broadcast media, in turn, have the disadvantage of not being able to provide more than a superficial review of happenings in the marketplace. In short, for both rural and urban residents, there has existed a need for a service with the capability of conveying as much business information as cost effectively as the newspaper at the speeds one takes for granted with the broadcast media.

In this instance, it does not appear that the needs of the rural businessman are greater than those of his urban counterpart, except that to the extent that improved information services are available in urban areas, he might suffer in competitive terms. Ultimately, with the advent of extremely high volume technologies such as fiber optics, the ability to "call up" business documents and correspondence might enable increasing numbers of people to work at home or in remote areas, thereby contributing to the trend of business decentralization to the countryside. For the moment, however, the kind of information services described below, while useful and representing a possible source of revenue to rural broadband systems, will not have revolutionary effects.

News wire services. Reuters, Ltd., the international news wire service, now provides a major information service available for transmission via cable television. Reuters' primary product for cable television is a two-channel package called "News-View" which supplies general news around-the-clock, financial news during the day and sports news at night. Until now, because of a lack of a reliable filter, or trap, to prevent non-paying viewers from using the service, cable television operators have been generally providing the

Reuters' service free of charge. Recently, however, the Long Island Cable Communications Development Corporation installed a microwave receiver at their cable system head-end, located on the roof of the Nassau County Medical Center, to receive such Reuters' services as updated stock market prices and race results. The added subscriber's fee for receiving this information is $3 per month (59).

To be able to offer this service, the cable operator must buy or lease a character generator from Reuters and then pay a monthly, or weekly, fee for the updated information. Reuters News-View rates are displayed in the following table:

Reuters-News-View Rates

News Fee Schedule

Size of System Number of Subscribers	Rate per Week
Under 1,500	$ 50
1,500-3,500	60
3,500-6,000	75
6,000-10,000	90
10,000-20,000	110
20,000-30,000	125
30,000-40,000	150
40,000-50,000	175

50,000 and more subscribers shall be at the rate of four cents per month for each subscriber in excess of that number.

Equipment Costs

Type of Equipment	Sale Price	Lease Price
Black and White Character Generator	$1,500	$95 per month
Color Character Generator	5,000	55 per week
Multi-Signal Input Character Generator	9,300	75 per week
Local Crawl Input	2,400	25 per week

Reuters transmits and updates the information provided to cable operators over leased common-carrier microwave channels. The service can also be provided with an optional "crawl" feature which allows the cable operator to insert locally generated information such as agricultural commodities data.

In addition to its News-View service, Reuters also supplies specialized information to professional clients such as commodities dealers, stock brokers, and bankers. Reuters calls this service "The Reuter Monitor" and clients can obtain such information categories as:

- Grains/Oilseeds Index
- Livestock Index
- Coffee/Cocoa/Sugar Index
- Financial Index
- Metals Index

In these cases the client has a terminal by which he can select desired "pages" of information. In New York these services are transmitted via Manhattan Cable's CATV system. The fees for the Reuters professional services will range from $300 to $1500 per month, depending on the type of service purchased.

Late in 1976, Reuters plans to distribute the professional and "News-View" service to cable operators throughout the United States by satellite. Traps, now being used by the cable industry for entertainment pay-TV service, can make it possible to restrict these services to paying clients.

Reuters estimates annual growth revenues for these services to be in the $20 to $40 million range within five years. Half of the revenue is expected from sales of their professional services, the other half from their News-View services.

Over-the-air information services. Systems are now being tested in Great Britain which are capable of supplying information, similar to that being supplied by Reuters, by broadcast. Encoded signals, sent during the vertical blanking interval (the interval when the television beam returns to the top of the screen to begin a new trace), are decoded and printed out on the subscriber's television screen (60). Neither of the "Teletext" systems will have the page capacity of the Reuters service. They will however, offer an over-the-air alternative to cable television delivered information systems.

Rural applications. In contrast to the public and commercial services considered thus far, the above applications do not require two-way broadband capability for their operation and could be used, if profitable, on any cable system with unused channel capacity. Together with pay television to be considered later in this Chapter, these services exist in a "canned" form and thus do not differ in kind from the news and entertainment services offered on conventional cable systems. Beyond the necessity that they be geared to generate sufficient revenue in the market served, no particular effort, as contrasted to the other services considered in this Chapter, has to be taken to develop or tailor the content of the services to be offered to the specific audience and set of institutions to be served.

Data Transmission

Rural needs. According to a recent NSF study, much of the research on business uses of telecommunications (especially as they might serve as a substitute for travel) has concentrated on the conduct of management operations (61-32).

While such research is essential, it seems likely that decentralization to rural areas of the so-called "information industry" (insurance companies and the like) is not going to occur until the capabilities for, and economic advantages of, the use of telecommunications by clerical and middle management workers have been demonstrated. Involved in the latter would be high-speed, high volume -- and routine -- handling of great quantities of information.

Because a great deal of literature already exists on "teleconferencing" similar broadband services appropriate to the needs of management personnel (61-17 ff.), no attempt will be made here to duplicate such analyses. Instead, this section will be limited to a state-of-the-art survey of high-volume data transmission technologies, and their use in two-way cable systems, and will conclude with a description of the only known application to date in which an operating broadband system is being used for these purposes by a major commercial institution (Bankers Trust Company of New York). A section on automatic meter reading will also be added in view of the potential this service offers for providing revenues and helping to underwrite the costs of broadband systems in low density rural areas.

Data transmission services. Until a decade ago, most remote data processing could be handled by low-speed teletype circuits. While technological advance in the computer industry have kept pace with the enormous growth that has taken place in the demand for data and information, the traditional telephone network, in spite of significant improvements in its data handling capability, has been hard-pressed to keep pace. While it is now possible to achieve processing rates of 9600 bits per second (bps) on leased telephone lines, throughput capabilities of the data processing equipment that originate the information to be transmitted have achieved levels of a million bits per second.

Thus, alternatives modes of data transmission are under study. The Bell System has been investigating developments in fiber optics where cables assembled with thousands of hair-sized "light pipes" will be used to carry voice and data communications (62). Throughput capacities will be orders of magnitude greater than any other system in use today. Another approach has been to set up a separate network, using microwave paths as the transmission media, which are dedicated exclusively the data transmission in digital form. Such systems provide up to 48,000 bps transmission rate. Still another approach has been to use coaxial cables. By using cable, it is conceiveable that immediate and near-future data transmission demands could be met. A single half-inch diameter cable, for example, has a throughput capacity equivalent to 30,000 full duplex telephone wire pairs.

There are a number of large industrial activities presently using two-way cable networks for internal communications. These include plants of General Motors, American Motors, Dow Chemical, and Kellog Cereal.

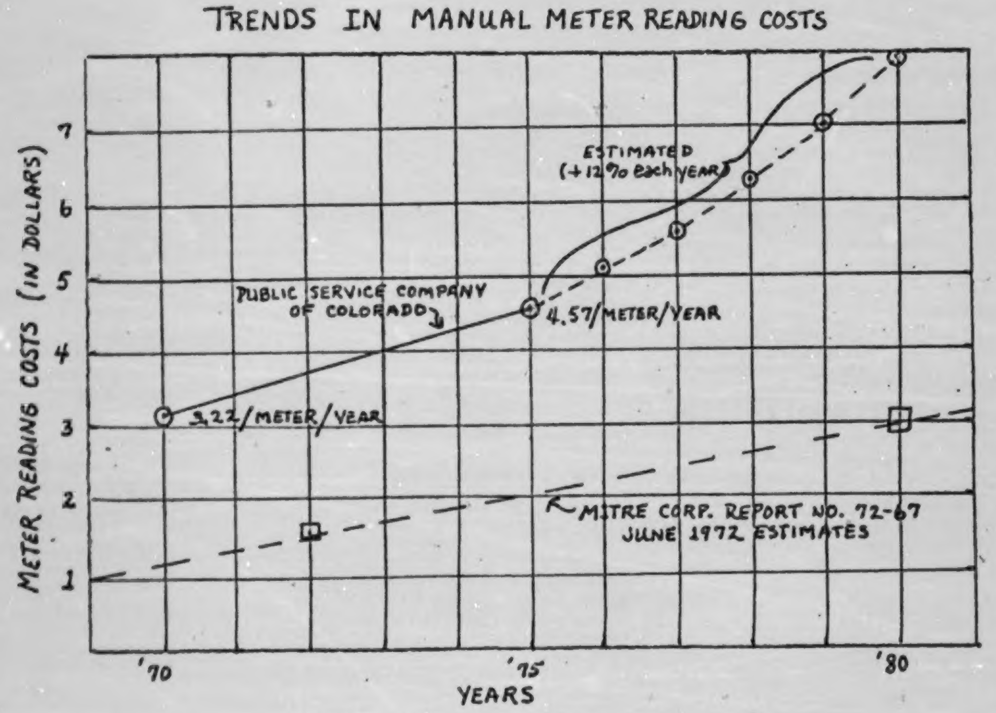
The systems are used to carry multi-channel closed-circuit-television, digital data and voice communications.

Recently , the Bankers Trust Company of New York began using the excess capacity of a cable television system operated by Manhattan Cable Television. The bank found the cable system to be a practical medium for transmitting the massive amounts of data that must be interchanged between their central office and their many branch offices.

Both the Chase Manhattan Bank and the First National City Bank in New York also are seriously exploring the Manhattan Cable network for transmitting data. To date, however, Bankers Trust appears to be the only business activity using an existing cable television network for data transmission. It is being used to update savings, demand-deposit and installment loan accounts; transmit data between the data center and the operations center; and transmit documents via high-speed facsimile equipment. Manhattan Cable has arranged a fee schedule for this service which is dependent on the amount of data that is transmitted rather than the the distance over which it is transmitted.

Rural applications. Rural banks must also convey large volumes of information to their branches and to other banks. Thus, this application is potentially attractive in rural areas. In addition, it should be noted that the approach reflected in the Bankers Trust application, that is using the full capabilities of a system to generate revenue, is precisely what is needed if broadband systems are to be economically feasible in low density rural areas. As with some of the other services discussed earlier, this application may be a good candidate for consideration in the system approach described in Chapter IV.

Automatic meter reading: rural needs. Since their inception water, gas and electric utilities have depended on manual meter reading to determine the consumption of their customers. This has been especially difficult and costly in rural communities because of the great distances between households and the large areas to cover. Automatic remote meter reading, long discussed but never implemented by utility companies, is being looked at anew because of the sharply increasing costs of manual reading as illustrated in the chart Further impetus comes from the recent and growing interest in management of electrical demand as a means of conserving energy and resources. Such management will require far more frequent reading of meters than is possible by manual methods.


TRENDS IN MANUAL METER READING COSTS

Traditional on-site measurement systems have a number of disadvantages that have continued to plague the utilities. These include:

- Skipped readings - when no one is at home to allow access to the meter(s);
- Adverse weather conditions;
- Need for a large fleet of vehicles;
- Vicious dog problems;
- Need for a large, attrition-prone work-force;
- Reading inaccuracies;
- Need to estimate billing because of skips and reading errors; and
- Effects of company holidays on reading and billing cycles (65).

For these reasons, consideration has been given to remote and automatic meter reading techniques using:

- Telephone distribution networks and automatic interrogation during off-peak hours;
- Cable television distribution networks and automatic interrogation, but not necessarily during off-peak hours;

- Electric power lines as a transmission medium; and

- Completely different schemes such as having the measurement instrument radiate signals which can be picked up by a utility truck passing by the house.

Potential benefits of using automatic systems include:

- Load studies -- to assure that pressure levels and voltages are maintained within the prescribed standards;

- Detection of service failures -- to determine the location of service outages after storms, earthquakes, etc.;

- Continuous operation -- readings can be taken 7 days per week, automatically addressing the problem of company holidays on reading and billing cycles;

- Elimination of skipped readings -- covering problems related to lack of access, adverse weather, viscious dogs, etc.;

- Fewer vehicles -- size of fleets could be substantially reduced;

- Reduced personnel problems -- related to hiring, training, and terminating personnel;

- Fixed costs -- automatic systems should be less sensitive to inflationary pressures;

- Increased reading accuracies -- reduction of questionable readings, skips, errors, etc.; and

- Other utility services -- such as turn-on and turn-off of valves, switches, etc. (65).

Over the years, a number of tests have been conducted using the telephone network for automatic meter reading; none of these resulted in an operational system. Today one of the most active companies promoting automatic meter reading via telephone is Darco Telemetering Systems, Omaha, Nebraska. In 1973 Darco, together with United Telecommunications and Iowa Power and Light Company conducted field tests in Avoca, Iowa. Those results prompted the Omaha Public Power District, People's Natural Gas Company and the Lincoln Telephone and Telegraph Company to initiate large scale tests, using the Darco system, in Ashland, Nebraska. One thousand houses will be wired to provide automatic and remote reading of electric, gas and water meters. Modification costs and telephone charges are tabulated below.

Cost Elements, Ashland Test. (In dollars)

	Costs/Household	Total (1000 Households)
Equipment Costs:		
Remote Unit	84.	84,000
Conversion Kit (3/house @ 1.50 ea.)	4.50	4,500
Control Console	3.82 (prorated)	3,824
Total Equipment Costs	92.32	92,324
Labor Costs:		
Installation and equipment costs shared by three utilities @ $40,918 each.	30.43	30,430
TOTAL	122.75	122,754
Telephone Charges:		
Per Reading/Location	.025	25
Lease Line Charges		2.25/month
Central Office Charges		14/month

In conjunction with the Ashland test it should be noted that (73):

- Special rates were developed by the telephone company for this service;
- Lines were connected to those houses that have no telephone service to provide 100 percent penetration;
- No protective coupler was used to interconnect to the telephone lines;
- The electric utility is collecting all of the data and transferring gas and water information to the respective utilities for billing
- The gas company has a control console which they use to interrogate industrial accounts;
- Present manual meter reading costs are between $4.25 and $4.60/meter/year; and
- Savings of 53.7 percent for residential accounts, and close to 100 percent for industrial accounts, are anticipated.

Although the DARCO tests used telephone lines for transmission, the use of cable for this purpose has been the subject of some examination. The Mitre Corporation study (65) compares costs of manual and automatic meter reading via telephone and cable. The study indicates that manual meter reading costs will double from early in 1970 to late in the same decade, primarily because of labor costs, whereas automatic meter reading costs will remain essentially the same. The study further indicates that using the telephone will be approximately twice as costly as using cable and that manual costs will be higher than automatic meter reading via cable by the end of the decade.

Tests of automatic meter reading were to be undertaken in 1974 on systems in Orlando, Florida and Irving, Texas, in conjunction with tests of two-way cable systems in general. Although the principals still express interest, lack of interest among potential subscribers and lack of adequate funding has forced the discontinuance of both of these tests.

The Darco system discussed earlier is adaptable to cable transmission systems. A primary concern of utility companies with regard to automatic meter reading and cable television distribution systems is the level of penetration. Unless close to 100 percent penetration can be achieved, cost savings and other benefits will be minimal.

The growing interest in energy conservation, and the potential of load management as a conservation technique, may prompt renewed interest in automatic meter reading. Effective load management programs may require "time-of-day" metering, demand metering, interruptable monitoring, and automatic usage control. Time-of-day metering would allow a rate structure which would vary according to varying energy demands and thereby encourage consumers to adjust usage schedules. Hourly measurements may be needed to effectively control such a rate system. A Canadian firm, Delta-Benco-Cascade, Ltd., of Rexdale, Ontario, has submitted a proposal to the U.S. Energy Research and Development Administration concerning the use of coaxial cable for these purposes.

Rural applications. Concerning the specific application of these systems in low density rural areas, it is unlikely that coaxial cable, installed solely for this purpose, could be cost competitive with existing telephone lines. Whether the charges for this service by a full service broadband system with a broad revenue base might be sufficiently low as to be economically attractive cannot be known in the absence of hard financial data, but it does seem that this possibility warrants further consideration.

Pay Television

Rural needs. In spite of the ubiquity of television, there are still many households in the United States which are beyond the reach of broadband reception -- either directly from the originating stations or relayed through the medium of translators or cable systems. More than one million households do not have access to any service; nearly six million do not receive adequate service on at least three channels and approximately 22 million do not receive adequate service on at least five channels. Most of these households are scattered among farms, ranches and small communities in rural America (71).

While there first has to be an existing broadband system before pay television can have any relevance to the above communities, still, as will be discussed below under the heading "Rural Applications", it is possible that pay television -- as a revenue source in broadband systems in low density rural areas -- might permit the opening up of some of these areas to television entertainment, as well as to the public service applications and commercial uses described earlier.

Pay-TV services. Since the beginning of television, the potential of supplying special program material on a pay-per-program basis has been the dream of entrepreneurs. Subscription television, or Pay-TV, was first seriously proposed in 1950 by the Zenith Corporation, whose first over-the-air pay-TV system, called Phonevision, was tested in Chicago in 1951. Opponents, however initiated a series of court battles which lasted into the early 1970's (72-8).

Recently, interest in pay-TV has been rekindled. Among the reasons are the now sizable and still growing television audience and the motion picture industry's search for new markets for its productions.

Technology is available either to distribute pay-TV programming over-the-air or by cable television systems. One of the proponents of over-the-air pay-TV has been Blonder-Tongue Laboratories, Inc., Old Bridge, New Jersey. Blonder-Tongue is a major manufacturer of components and systems for the television industry. In the late 1960's the company introduced a system which would allow broadcasters to provide over-the-air pay-per-program television. The system employs an encoder ("scrambler") which suppresses the horizontal and alters the vertical synchronization pulses causing the picture to appear seriously distorted. The sound is also interrupted. When the home subcriber desires a specific program he activates a decoder ("descrambler"). The home subcriber can purchase the decoder for $130 and then pays a specified amount for each program (68). The company has also developed a system for flat rate payment by the month. In this case the home decoder costs the subscriber $70, with the monthly rate to be determined by the broadcaster. To date, however, over-the-air pay-TV has attracted only limited interest.

Within the cable television industry there also has been a continuing interest in finding a way of exploiting the profit potential of pay-TV. Of all of the broadband services discussed in this Chapter, pay-TV is seen by those in the cable television industry as having the greatest immediate potential of generating additional revenue.

Although pay-TV by cable did not achieve rapid growth until late in 1972, the demand has already far exceeded the expectation of the industry and almost exceeded its ability to supply such services (69-9). Today nearly 400,000 subscribers have paid $10 to have the necessary equipment installed and are paying a monthly fee of $6-9 to receive this service. The needed equipment is essentially a filtering device which will allow the transmission of the pay-TV programming when activated and "trap" the signals when deactivated. In most cases the hardware is installed in the subscriber household, but in some cases it is located externally where the subcriber drop is tapped into the feeder cable.

On September 30, 1975 Home Box Office (HBO), a subsidiary of Time Incorporated, began its service of delivering pay television programming by satellite with live coverage of the Ali-Frazier fight from Manila. The fight was seen in 25,000 homes via cable television. Receive-only earth stations are now available for approximately $65,000-75,000, making it possible for most of the larger cable operators to become part of the pay-TV network and receive special events programming .

It has been predicted that there will be 2 million subscribers for pay-TV in 1980 (69-9). At the present time, the operator is expected to purchase the earth receiving station and in addition to pay HBO approximately 50 percent of the revenue collected from subscribers. HBO prepares the programming and is responsible for transmitting the program material via satellite. Although the subscriber now pays a flat monthly fee, it is anticipated that programming will ultimately be sold on a per-program basis.

Rural applications. Providing pay-TV to rural areas may require different approaches than in more densely settled areas. For example, the cost of an earth station, not out of reach for the cable operator who has subscribers numbering in the tens of thousands, may be out of the question for a system with subscribers numbering in the hundreds. It has been suggested in the literature that smaller operators could form "cooperatives" to share the costs of the earth station among a number of cable systems (70-20). The concept of cable systems working together financially and technically is not a new one. Many existing community antenna relay installations are jointly owned but used by separate operators (71-33 ff.).

Other modes of supplying pay-TV in smaller rural areas are also available. Tapes might be leased by the cable system operator and played on a video tape recorder over the system. Another option is to lease channel space to and provide collection service for a pay-TV company for agreed upon rates. Finally, pay-TV might be distributed over-the-air using translators.[1]

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[1] Because translators broadcast signals over the air, the signals can be picked up by any set. To ensure payment, either the community can designate a special taxing district or the signal can be scrambled and individual subscribers pay for use of decoding equipment. However, the last technique would require changing FCC regulations (72).

Since pay-TV, like the information services discussed earlier, delivers "canned programs", the only barrier to its adoption by rural systems of the type contemplated in this report is one of economics (sufficient market and revenue when related to costs). Unlike the rest of broadband services discussed in this Chapter, no effort is required on the part of the system operator or his consultants to devise program content and tailor it to the customers intended. Pay-TV represents the older, "conventional" purposes to which broadband might be put. However, pay-TV might serve the further function of providing sufficient additional revenue to help make a rural system economically feasible.

Summary And Discussion

Actual and potential uses of broadband communications to meet rural needs in the public service areas of health, education, law enforcement and government/administration were examined in this Chapter. Potential commercial uses of broadband systems for security, information services, data transmission and pay-TV were also reviewed.

Public Service Applications

In both health and education, rural needs derive from shortages and inadequacies of facilities and personnel, as well as from the many factors that make access difficult, such as distances to be travelled. Principal factors contributing to shortages and inadequacy of personnel in the health area include isolation from peers, from specialists and from health care facilities. In both the health and education areas, it is difficult for remotely located personnel to maintain currency in their fields and to continue their training. Financial resources, that is, lower incomes than in urban areas, the fact that fewer rural residents are insured for health care, and the generally smaller tax base available to support facilities also contribute to the reduced opportunity for health care and education in rural areas.

In health, a vigorous experimental program conducted over the last twelve years has demonstrated the feasibility of using broadband communications to meet rural needs in five basic areas of health care; namely, consultation, supervision, direct patient care, administration and management, and education and training. Patient acceptance is high and it has been demonstrated that telemedicine can increase the adequacy of health care by providing access to services which were not available before or which were available only to a minimal extent. For health manpower personnel, some problems remain such as ensuring privacy and confidentiality in the doctor-patient relationship, the possibility of increased workloads, and a feeling that supervision of nurse practitioners and physician assistants is sometimes excessive. Otherwise, attitudes of medical presonnel involved generally have been found to be favorable. However, if these services are to be widely used, change in some state laws will be required.

Major unknowns requiring further research include comparisons between the relative costs of video vs. non-video systems, and the best ways to combine manpower and technology for total health care delivery systems that can be self-supporting financially.

Fewer experiments using two-way communications have been conducted in education, especially in rural areas. Nevertheless the technical feasibility of meeting many educational needs of rural areas has been demonstrated. There is, however, a lack of information concerning the particular technical capabilities needed to support educational uses, as well as concerning the relative effectiveness of education using communications when compared to the traditional classroom. Educational programs adapted to broadband use and/or guidelines for their development are also needed. Generally, little hard data are available on the cost-effectiveness of using broadband communications for education.

For both health and education, it should be noted that cost-effectiveness should not be considered as the sole criterion for use of broadband communications. This is because use of broadband may be the only alternative available. Nevertheless, further experiments should include evaluation of effectiveness, collection of cost data, and alternatives analysis as an intergral part of the study design.

Rural needs in law enforcement derive from the large distances involved and the time consumed in travel to and from the central station, which reduces the time available for assigned duties. In some rural areas, it is estimated that up to one-fourth of the working day of a law enforcement officer is devoted solely to travelling back and forth to central headquarters. In this connection, broadband communications could be used to televise roll calls and briefing sessions, transmit fingerprints and related documents, and conduct some pre-trial arraignment procedures. An innovative experiment in the city of Philadelphia will test some of these concepts, which might be of value in some rural areas.

Government and administrative uses are also potential areas of application. For example, where processing of claims and applications requires more than one agency, broadband communications might reduce requirements for travel and processing time, thereby reducing costs to local governments. An experiment underway in Spartanburg, South Carolina, will provide data on the effectiveness and costs of using broadband communications for this purpose.

Commercial Applications

Four classes of potential commercial applications were examined. These were: security systems, information services, data transmission, and pay-television.

Rural needs for security services include detection of fire and unlawful entry. Fire losses on farms in 1970 totaled $242 million and insurance premiums paid by farmers to cover fire and wind damage totaled $441 million. As for crime, one category in particular, unlawful entry, has increased in rural areas at a rate nearly double that in cities and four times that in Standard Metropolitan Statistical Areas.

A rural broadband system could assist in reducing these losses by permitting continuous monitoring of isolated building from a central location. The firm of TOCOM, Inc. of Irving, Texas, has developed such a system, and it is commercially available. In addition to centrally-monitored smoke, fire and intrusion detectors, the TOCOM system can also be used for opinion polling and meter reading. So far, the primary market for TOCOM's system has been new communities where wiring and installation of detection devices is accomplished during construction and paid for by the builder. The homeowner pays a monthly subscriber fee; however, as a result of the features of this system, insurance companies have offered discounts that offset much of the amount of the subscriber's fees. Although the economic viability of these systems in rural areas remains to be tested, they represent a potential component of rural broadband systems.

In the area of information, services are available which provide stock and commodities' prices, round-the-clock news and other business data. These services are presently available, if the necessary market exists, and could be readily provided on rural broadband systems.

In the area of business uses of broadband systems, the following applications were considered: 1) high volume data transmission; and 2) automatic meter reading. Communications of large amounts of data between headquarters and branch offices is required by many institutions and can be accomplished by transmission on a broadband system. One example is the Bankers Trust Company on New York which uses the excess channels of a local cable television system for transmitting the massive amounts of information that must be interchanged between the central office and their many branches. The system is used to update savings, demand-deposit and installment loan accounts; transmit data between the data center and operations center; and transmit documents via high-speed facsimile equipment. The bank pays a fee to the cable company for use of the system. Although this service has not been tested in a rural area, it shows how a broadband system can be employed to generate revenue from institutional users.

The potential for automatic meter reading arises from the fact that manual reading of meters for water, gas and electricity is especially costly in rural areas because of the long distances involved. Estimated costs for manual meter reading are projected to approximately double between 1975 and 1980, primarily due to increased labor costs. While meter reading does not require a broadband system and can be accomplished over telephone lines, a recent study indicates that using telephone will be about twice as costly as using cable and that manual costs will be higher than automatic meter reading via cable by the end of the decade. In addition, automatic meter reading, since it can be done as often as necessary, permits management of electricity load, which is a potential energy management technique. These factors suggest that utilities might find automatic meter reading attractive in rural areas, thereby providing additional revenue to support a community broadband system.

The final commercial application reviewed was pay-TV for which subscribers pay a fee to obtain special programs and sports events. This service, increasingly available in urban areas, could also be made available in rural areas. In the context of this report, the value of pay-TV lies in its potential for generating additional revenues to support a multiservice broadband communication system.

Discussion

This Chapter has shown that there are many areas where broadband communications could be used to meet rural needs. A variety of public services can be provided and there are a number of uses which are potentially attractive to commercial institutions.

A major characteristic of many experiments in the public service sector is that they have been directed at demonstrating technical capability. Economic feasibility and the design of economically viable systems have received less attention. When cost-effectiveness has been considered, it has been limited to the use of technology to provide a single service. Detailed consideration of a system approach to broadband communications in which costs are shared by public service users, commercial users and subscriber-supported entertainment fees, has not been attempted. However, such a systems approach may be the key to a broadband system serving an entire rural community.

All the public service and commercial uses described in this Chapter have potential for inclusion in a rural broadband communications system. The particular public service and commercial uses included will vary according to the characteristics of each rural area. Selection for a specific rural community should be based on a comprehensive needs analysis.

CHAPTER II

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CHAPTER III

RURAL DEVELOPMENT AND BROADBAND COMMUNICATIONS

Although communications has been commonly portrayed as an agent of possibly revolutionary change in American life, the aim here is limited to considering the contribution that broadband might make to the specific goals of rural development as spelled out in recent legislation on the subject.

In the last decade there has been increasing concern about the tendency of the United States population to concentrate in urban areas. The attendant congestion, pollution, strain on public services, increase in crime and similar characteristics of urban living have suggested that the present and projected scale of urbanization in the United States may not be desirable. Concern was greatly exacerbated by the riots in Watts, in Detroit, and in other urban areas (1-3; 2-3).[1] As a result, beginning in 1970, the concept of a national growth policy was developed which had as its premise the need to redress the balance of population between urban and rural areas. This policy was described in such legislation as the Housing and Urban Development Act of 1970 and the Agricultural Act of 1970, and was the subject of recommendations by the Citizen's Advisory Committee on Environmental Quality of 1971 (3-3). Congress also gave explicit consideration to how such change was to be accomplished. For example, the Rural Development Act of 1972 aimed to improve the quality of life as well as employment opportunities in rural areas and thereby increase their attractiveness compared to urban areas. Concerning the priority to be accorded rural development Title IX of the Agriculture Act of 1970 specified that:

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[1] References are numbered consecutively in the order of their first appearance in the text. The first number is the reference. The number after the dash is the page number in that reference.

> "The Congress commits itself to a sound balance between rural and urban America. The Congress considers this balance so essential to the peace, prosperity, and welfare of all of our citizens that the highest priority must be given to the revitalization and development of rural areas."

Although the legislation cited is of recent vintage, Federal programs for the last forty years have had a great impact upon rural America in such areas as agriculture, transportation, electrification, and social welfare. Because of the long duration and complexity of change in rural America, the approach taken in the Chapter is to try to identify those key economic and social forces that seem to underlie the major alterations now underway. Subsequently, an attempt is made to show how broadband systems of varying configurations might meet the future needs created by the continued operation of these economic and social forces. Future needs are addressed because the establishment of area coverage rural broadband systems also lies in the future; none presently exists.

Rural-Urban Population Distribution And Migration Patterns

This section explores distribution of population in rural and urban areas and recent patterns of migration between these two areas. There are two reasons for doing this. First, one objective of rural development is to affect the balance between rural and urban population size and, in this study, we are interested in the role broadband communications might play in such an alteration. Therefore, it is important to identify current trends so that it can be seen whether the objective towards which such systems might contribute would be helping to initiate a shift in population towards rural areas or helping to facilitate (or constrain) a shift which is already occurring. Second, the characteristics of populations in rural areas will determine the types of broadband services which can best meet the needs of rural people. For example, a high proportion of youngsters implies a need for educational service. Medical services are especially important to an area with a high proportion of older residents.

Our investigation in this area resolved itself into a series of questions. The material in this section has been organized around these questions. As will be seen, not all questions have satisfactory answers, or where answers are provided, the data are sometimes less complete than desired.

Definitions

There are a number of definitions of rural and urban. For example, the Department of Agriculture by statute uses several different definitions, ranging from open country and places of 1,500 people up to all cities of less than 50,000 population. The U.S. Bureau of the Census defines rural as "open country residents and people in towns of up to 2,500 inhabitants" (4-669). The diversity of definitions has caused the Rural Caucus to request a survey of definitions of "rural" from the Library of Congress.[1]

In this section, the terms "metropolitan" and "nonmetropolitan" will be used rather than "urban" and "rural". The reason is that the available data on recent population trends are organized in these terms. (In overall totals, the differences between "rural" and "nonmetropolitan" are not large: 53.9

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[1] Definitions of rural and urban are necessary not only to explore population trends but for purposes of identifying the applicability of various sources of Federal funds to support rural applications of telecommunications. This is discussed in Chapter IV of this report.

million were classified as rural in the 1970 census; 54.3 million as nonmetropolitan.)

The metropolitan area is a county in which there is an urban nucleus of at least 50,000 people. Adjacent counties are included if 30% or more of the population commute to the urban core. If less than 30% but more than 15% of the workers commute, the adjacent county is still considered metro if it meets two out of three subsidiary criteria considered characteristic of metro areas. These criteria refer to density, degree of urbanization and rate of growth. Other areas are classified as nonmetropolitan (4-669; 5).

In The Recent Past And Today, How Many People Live In Metro Areas And How Many Live In Nonmetro Areas?

While the overall U.S. population increased from 1950 to 1974, the percentage of those in nonmetro areas has declined from 33% to 27%. A closer examination shows, however, that the tendency for the population to concentrate in metro areas is decreasing. From 1950 to 1960, the percentage of population in nonmetro areas fell from 33.3% to 29.0%, a drop of 4.3 percent. From 1960 to 1970, the nonmetro proportion continued to drop, but at a lesser rate of 2.3 percent. Thus, in 1970, 26.7% of the population lived in nonmetro areas. Finally, in the period 1970-74, the trend reversed itself, with nonmetro areas showing a net gain to 27 percent of the country's population, (1950 and 1960 based on data in 6-21; 1970 and 1974 based on data in 7-2).

What Are The Recent Trends In U.S. Population Growth? How Do Metro And Nonmetro Growth Rates Differ?

The rate of U.S. population growth is decreasing. Growth in the 1960-1970 decade was less than in the 1950-1960 decade. The 1970-1974 figures suggest that the 1970-1980 decade will show even less growth.

When U.S. population growth is subdivided into metro and nonmetro growth, it is clear that growth in metro areas in the last 25 years has declined more precipitously than that of the U.S. population as a whole. Between 1970 - 1974, U.S. population grew by 4.0 percent whereas metro areas grew by only 3.4 percent. Nonmetro areas, on the other hand, grew by 5.6 percent during the same period (7-1). This is the first time in the twentieth century that nonmetropolitan growth has exceeded metropolitan growth (2-6). (1950, 1960, 1970 based on data in 6-21; 1974 based on data in 7-2.)

One Factor Which Could Cause A Shift In Population Between Metro And Nonmetro Areas Is Migration. (Another Is Different Birthrates.) How Have Nonmetro Migration Patterns Changed Over The Last 25 Years?

Between 1950 and 1960, migration from nonmetro areas exceeded inmigration by more than 6 million persons or more than 12% of the 1950 based population of 50.4 million persons. In the 1960-1970 decade, nonmetro areas still lost more population than they gained but by half the rate of the preceding decade.

The 1970's have seen an actual reversal of previous nonmetro losses. Over the last four years, a net of 1.6 million persons moved into nonmetro areas, a 3% increase over the 1970 base population of 54.3 million persons. (1950, 1960, and 1970 based on data in 6-21; 1974 based on data in 7-2.)

How Has The Birthrate In Metro And Nonmetro Areas Affected Population Growth?

Between 1971 and 1974, a higher birthrate in nonmetro areas appears to have contributed to a higher population growth in nonmetro areas as compared to metro areas. During this period, the largest metropolitan areas of the country showed the greatest decline in birthrates. While fertility rates of metro and nonmetro areas converged from 1940 to 1970, during the period cited there appears to have been a divergence, with higher rates in nonmetro areas (2-13 ff.). However, higher birthrates are not the major explanation of nonmetro growth. Changes in migration patterns have played a predominant role as described above.

Does The Shift In Population Towards Nonmetro Areas Represent Suburban Sprawl? Is It Simply Migration To Rural Areas Adjacent To Metro Areas?

Migration from metro to nonmetro areas does not simply reflect expansion of existing urban areas. Of the 1.6 million persons moving into nonmetro counties in the period 1970-74, 62% moved into counties adjacent[1] to metro areas. However, 38% moved into counties not adjacent to metro counties. These changes are particularly dramatic when compared to migration movements in the preceding decade, in which non-adjacent rural counties lost 2.3 million people. (Based on data in 7-2.)

What Proportion Of Nonmetro Counties Are Expanding In Population?

The U.S. is made up of 3100 counties or county equivalents (5-2). Of these, 630 are metro and 2470 are nonmetro. Somewhat more than half (1461) of the nonmetro counties are not adjacent to metro counties. These are the most rural counties.

The 1970's were characterized by a large increase in the proportion of nonmetro counties which are growing, especially nonmetro counties not adjacent to metro areas. For example, 84% of nonmetro adjacent counties were growing in the 1970-1973 period compared to only 60% in the 1960-1970 decade. For nonmetro counties not adjacent to metro counties, the change in the proportion of growing counties is greater. In 1970-73 period, 70 percent were growing, whereas in 1960-1970, only 39 percent were growing (6-23).

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[1] Counties classified as adjacent are characterized not only by geographic proximity but also because at least 1% of this force commuted to the metro central county for work (6-12).

Migration patterns are playing a major role in growth. There has been a sharp increase in the 70's in the proportion of nonmetro counties growing by net inmigration (6-23).

Is Most Of The Migration Into Nonmetro Areas To The Most Densely Populated Places?

In absolute numbers, more than half this migration has been to rural counties adjacent to metropolitan areas, which are on the average most densely populated. However, the sharpest increase in migration has occurred in the less densely populated areas. Additionally, within counties of both categories, growth has tended to be greatest outside the corporate limits of towns (6-22).

Is Nonmetro Growth Limited To Certain Sections Of The Country?

No. As stated in Reference 2 (pg. 7): "As measured by migration trends, all states but three (Alaska, Connecticut and New Jersey) show it (increased retention of population in nonmetro areas) and two of the three exceptions are controlled by events in military base counties. Nonadjacent (to metro areas) counties have had some net inmigration in every major geographic region."

Factors Underlying Rural Development[1]

As has been shown, there is reason for believing that the long-term decline of many rural areas of this country is presently in the process of reversal.

The object of this section will be to survey some of the major explanations that have been advanced for this development. The third and final section of the Chapter will bring these theories to bear in an attempt to understand the changes now underway in three principal categories of nonmetropolitan counties; to identify the indicated future needs of the rural areas in question; and, finally, to consider the role that broadband communications might play in addressing these needs.

Decentralization Of Manufacturing

In the decade of the 1960's, the principal engine of economic change in rural America was the growth of manufacturing. As farm employment continued its decline, nonfarm jobs took up the slack and grew at a faster rate than in urban areas. Manufacturing dominated this growth in rural nonfarm jobs and increased at an annual rate of 4.6 percent during the decade. This growth occurred at the expense of urban areas; by the end of the decade 25 percent of all U.S. manufacturing was located in rural areas, up three percent from 1960 (8-1).

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[1] While it is not the purpose of this study to attempt to break any new ground in understanding the factors underlying rural development, existing literature on the subject is unsatisfactory in that it does not provide comprehensive theories of development that can account for recent data on rural population changes. In this section, the subject is approached in the form of a critical commentary upon several of the prominent theories of rural development. In view of the limited scope of this study, this analysis is not definitive; rather, it represents a useful way to "think about" the subject of rural development.

This growth in rural manufacturing -- as well as the recent reversal of migration from rural areas -- seems to undermine the hypothesis of many scholars that there will be ever-increasing urban dominance. However, this hypothesis is still influential. To accommodate and explain such departures from the historical trend of rural decline, it has been suggested that growth of manufacturing in rural areas involves dying industries which migrate to rural areas in search of cheap labor or land. According to this view, nothing is really changed by such relocation: urban areas will continue to take the lead in inventing and developing products; the rural areas will remain the temporary lodging places of dead-end and low paying enterprises that do little to develop further their economic base. Wilbur Thompson describes the process as follows:

> "In national perspective, industries filter down through the system of cities, from places of greater to lesser industrial sophistication. Most often, the highest skill requirements decline steadily as the production process is rationalized and routinized with experience. As the industry slides down the learning curve, the high wage rates of the more industrially sophisticated innovating areas become superfluous. The aging industry seeks out industrial backwaters where the cheaper labor is now up to the lesser demands of the simplified process" (9-8).

One team of researchers, after analyzing industrialization in 24 rural counties, concluded that rural areas might be permanently condemned to a position of inferiority compared to the rest of the economy:

> "This type of firm (likely to relocate to rural areas) faces serious problems whenever the national economy goes through a period of below-normal growth. Because of the highly competitive nature of their industries, and because these firms do not usually have large cash reserves, they are especially vulnerable in periods of tight money, or low consumer demand...

> It may be even more important to note that those industries normally contributing the most to rural growth are also the industries that tend to grow more slowly than the national economy even in a period of national prosperity. As the economy becomes more affluent, the service industries grow more rapidly than do the manufacturing sectors, while within manufacturing itself the 'light' industries most important in rural manufacturing, such as textiles, food, and lumber and wood products, tend to lag behind their 'heavy' counterparts. *Thus, in general, rural industrialization can never yield the same long-run growth rates as the national economy*" (10-60). (Italics added)

If these analysts are right, and if this kind of industrialization for rural America is in some way preordained, then it follows that there is little that broadband communications or any other technology can do to alter the pattern.

The evidence, however, does not completely support this theory. While employment in apparel and other low technology industries has accounted for much of the sharp increase in rural manufacturing employment, an analysis by Claude C. Haren of the U.S. Department of Agriculture of nationwide rural industrialization in the 1960's reveals a far more diverse and growth-oriented picture. Haren states that:

> "Undoubtedly the greatest increment in rural areas was in products that found direct or fairly direct outlets in consumer channels. But, notably within and on the margins of the Great Lakes Industrial Belt and in parts of the Upper Southeast, many items manufactured by new plant additions or expansions were primarily for the industrial market...
>
> Added or enlarged were firms producing not only farm fertilizers, but pharmaceuticals and a broad range of industrial chemicals. In addition to plants turning out farm machinery and equipment, a far greater and increasing number were manufacturing industrial machinery, control equipment, transformers, electric generators, motor vehicles and parts, and aircraft and aircraft components. Blast furnaces, reduction plants, and rolling mills were installed at strategic small cities and towns,

> notably along the Ohio and Mississippi Rivers. Even more numerous and varied were expansions in metal-working facilities for the production of such industrial hardware as dies, machine tools, structural metal, stampings, piping, and tubing" (11-433).

A second development undercutting the theory that rural industrialization inevitably is limited to low technology industries is the demonstrated growth in rural areas of precisely that "service" sector of the economy that has been the hallmark of urban dominance. This will be discussed next.

Decentralization Of The Service Sector Of The Economy

Of all the economic developments that might lessen the past trend of urban centralization in our society, none would be of greater long-range significance than the relative growth in rural areas of the non-goods producing service sector of the economy.

The characteristics of the service sector and the reasons why it has been of central importance in understanding the heretofore dominant influence of urban areas were eloquently described by Wilbur Thompson as follows:

> "The true economic base of the great city-region (lies in) the creativity of its universities and research parks, the sophistication of its engineering firms and financial institutions, the persuasiveness of its public relations and advertising agencies, the flexibility of its transportation networks and utility systems, and all the other dimensions of infrastructure that facilitate the quick and orderly transfer from old dying bases to new growing ones. A diversified set of current exports -- breadth -- softens the shock of exogenous change, while a rich infrastructure -- depth -- facilitates the adjustment to change by providing the socioeconomic institutions and physical facilities needed to initiate new enterprises, transfer capital from old to new forms, and retrain labor.

> Large places are also better based to adapt to innovations originating elsewhere. With a wider assortment of educational institutions and more professional counseling, local workers may be more quickly retrained from declining to expanding occupations. Reemployment can often be achieved within the same local labor market, eliminating the very difficult residential relocation characteristic of smaller places" (9-8).

Although metropolitan counties continued to lead in the growth of the service sector through the 1960's, there is now evidence that this historic trend as well, may be in the process of reversal. In a November, 1975, statement before the House Post Office and Civil Service Committee, Calvin Beale, of the U.S. Department of Agriculture said:

> "Since 1970, employment in all major industry groups has grown at a faster rate in nonmetropolitan than in metropolitan areas with the exception of government jobs. *In other words, the pace of employment growth in trade, services, construction, transportation and utilities, finance, and real estate has followed the lead set by manufacturing in the 1960's*, and is more rapid in the rural and small town areas than in the metro cities and their suburbs. This growth was interrupted by the current business recession, but since the Spring of 1975 it appears that the nonmetropolitan areas are recovering from the recession faster than the metropolitan areas are" (7-3). (Italics added)

Despite this recent evidence, however, there are still those who contend that this rural resurgence is more apparent than real. In their view, what is being reflected in these statistics is simply urban expansion in another guise, with cities extending their physical limits -- and presumably the location of their service industries -- by incorporating adjacent rural areas. Commenting upon increased rural growth rates in the Upper Midwest, Neil C. Gustafson of the Upper Midwest Council said recently:

> "Recent interpretations of these trends have led many people to believe that urban expansion has been abruptly halted or even reversed. Closer investigation of these data, especially as they related to the Upper Midwest, indicate that such conclusions require clarification. Most of the population growth in the Upper Midwest has been and continues to be urban expansion, but the range of urban growth has extended far into the countryside and to the small towns within commuting range of the employment centers. The largest volumes of recent population growth in the Upper Midwest remain near and related to major urban areas" (12-15).

As it happens, there is another group of experts who have analyzed the same outward movement of population and service industry from urban cores and has found evidence not of simple urban expansion, but rather of the evolution of a new kind of rural-urban hybrid which they label "urban fields". These they define as being "a fusion of metropolitan areas and nonmetropolitan peripheral areas into core areas each with a minimum population of 300,000 persons and extending outward for approximately one hundred miles, that is, a driving distance of about two hours" (13-13).

Concerning the specific characteristics of these amalgams of cities and the fastest growing rural counties, Niles Hansen found them typically to rank high in the following kind of service industries: wholesale and retail trade, transportation, finance, insurance, and real estate (13-39).

The Federal government, although not using the term "urban field", has in recent years incorporated such hybrids into their adjacent metropolitan areas. According to Claude Haren, 83 metro fringe counties, including "a strong representation of essentially rural and partly rural units were added in the past several years to the Indianapolis, Columbus, and other

SMSA's, primarily on the strength of having specified percentages of their work forces commuting to the core counties in which those and other SMSA central cities are located" (8-8).

It cannot now be known with certainty how or whether rural areas can share in this growth of the service sector of the economy and still maintain their identity. Alternatively, they might wind up being submerged either in urban sprawl or in the more scattershot, but still potentially as anonymous, character of life in urban fields. The third section of this Chapter will address the role broadband communications might play in helping to foster a less dislocating, and more rural-centered, form of development.

Residential Preference

A third factor that has had a sizable influence upon the relative growth of rural areas in recent years has been the growing preference of a majority of the U.S. population to live in rural areas or small towns.

In 1970 Louis Harris and Associates reported that while 68 percent of the population lived in cities, only 48 percent expressed a desire to continue living there (3-17). Subsequent polls refined this stated preference to being one for living in nearly rural or small town areas. However, Calvin Beale has pointed out that these polls also indicated that a more remote rural or small town area was the expressed second choice of those preferring to live in the country (2-16). Another survey cited by Beale which dealt with the likelihood of persons actually moving on the basis of their stated preferences, showed three-eighths indicating they were "very likely" to move to rural areas within "the next few years" (which translates, according to Beale, into 14 million potential movers) (2-17).

Clearly, whatever disagreement might exist over the fine points of these analyses, a sizable fraction of the urban population would prefer to live in rural areas.

Of course, unless there is also some realistic prospect that these people can subsist in rural areas, such an expressed desire would remain of academic interest. The prospect for such a move, however, has become more realistic for an increasing fraction of the urban population.

First, as cited by Niles M. Hansen, jobs are increasingly less resource and land-tied. While this does not dictate a shift from urban to rural areas, it does permit vastly increased mobility:

> "It has been estimated that whereas less than forty years ago nearly 30 percent of the labor force needed to be located close to natural resources, today only 7 percent are resource-bound. Thus, the great preponderance of workers now are potentially 'footloose' or must locate in proximity to consumers who themselves are relatively footloose, and economic opportunity is associated less with land and natural resources and more with the presence of capital and human skill" (13-8).

Second, the combination of increased disposable income, governmental programs such as the Interstate Highway network, early retirement, increased vacation time, and changing lifestyles favoring outdoor recreation, has led to and made possible increased population movement to rural areas. Although some of the data cited below have probably changed due to the recent recession, Hansen's 1973 description of the many factors at work gives some indication as to why more dissatisfied city dwellers have been able to vote with their feet:

> "In the past metropolitan growth has tended to draw off productive population and investment capital from hinterland areas, but in the future centrifugal

> forces will reverse this pattern. For one thing, the hinterlands have space, scenery, and communities that are increasingly attractive to metropolitan populations. Demand for these resources is being generated by rising real income, greater leisure, and increasing mobility. Personal income in 1972 has been estimated at $920 billion, a gain of almost 50 percent in a five-year period. Over 40 million Americans now work under employment conditions entitling them to three-week vacations. Federal law now provides five three-day weekends each year, and a trend toward a four-day work week is clearly in evidence, with about two thousand companies now following this procedure. Earlier retirement has been encouraged by improved pension plans and high Social Security benefits. Access to nonmetropolitan hinterlands has been vastly improved; for example, when the Interstate Highway System is complete an estimated 3.5 to 7.5 million acres will be opened for development.
>
> Dollar sales of leisure equipment (an estimated $105 billion in 1972) have increased by 52 percent over the past five years, reflecting an accelerating desire to 'get back to nature'. A survey by the Department of the Interior indicates that three quarters of the American population nine years of age and older is involved in some form of outdoor recreation...Moreover, about two million American families own second homes used for vacationing, and the number is increasing each year by from one hundred and fifty thousand to two hundred thousand units...About one third of the total mileage driven in private automobiles is devoted to getting to and from vacation areas. Clearly, satisfying leisure-time desires already represents a major opportunity for many nonmetropolitan areas, and growth prospects in this regard have few parallels" (13-13).

The lengthy list of enabling factors just cited is the more impressive because of its sweep and diversity. Should economic conditions, for example, cause a downturn in outdoor leisure activities, other trends less susceptible to short term economic fluctuations, such as the increased use of rural areas as retirement locations, could help to sustain the long-term shift to these areas. In this connection -- and this might presently be helping to counter the effect of downturns in other economic activities affecting migration to rural areas -- it is relevant to note that so-called rural "retirement" counties (net inmigration of 15 percent or more of persons aged 60 and over) have taken the lead as the most rapidly growing class of nonmetro counties in the 1970's (2-10). Further to this point, Beale has distinguished 60 nonmetropolitan counties in which the number of retirees receiving Social Security payments increased by more than 50 percent between 1970 and 1975 (7-4). In total, "retirement" counties in rural areas now account for a population of 8.7 million in 377 separate counties (2-11).

If it is likely that some sizable fraction of the urban population will continue to prefer living in rural areas and small towns, and if the evolution of the U.S. economy makes it increasingly possible for city-dwellers to act upon their preferences, then the quality of public services and the amenities offered in rural areas becomes especially important in affecting the future course of this migration. Once some sizable fraction of the American population is not required to live in a given area because of sheer economic necessity -- and as soon as their movement is able to be more voluntary and discretionary -- then relative attractiveness for daily living becomes an important factor affecting rural growth. This development and the possible utility of broadband communications in improving the quality of public services in rural areas will be further addressed in the next section of this Chapter.[1]

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[1] It should be emphasized that this survey of the factors that underlie the recent reversal of urban dominance in population growth has been highly selective. Left out were such factors as the location of state colleges and other state facilities, and the revival of such traditional rural enterprises as mining operations, both of which have been identified as causes for growth in rural counties not adjacent to metropolitan areas (14-15). Also omitted in trying to distinguish the common denominators of rural growth was a stated

recognition of the diverse nature of rural America. It is far from the case, for example, that every rural county within two hours driving time of core cities can be considered as part of an "urban field". Nor is it true, as another example, that decentralization of manufacturing has made its influence felt in all rural areas. As described by Claude Haren, an equally large or larger number of nonmetropolitan counties has not been affected by industrialization, especially in the areas of the Great Plains, the Intermountain Region, and Alaska (8-12).

This selection of decentralization of manufacturing and decentralization of the service sector of the economy, plus residential preference, as the major forces underlying the recent population growth in rural America does not reflect a conclusion that only these forces are of sigificance. At the same time, it should be noted that decentralization of manufacturing and of the service economy are the principal distinguishing characteristics, respectively, of those nonadjacent and adjacent rural counties that have shown the greatest growth in recent years. Residential preference, in turn, seems to have accounted for that rural growth which is not strictly economic in origin.

The foregoing commentary addressed two basic questions:

- how is rural America changing?
- what are the forces underlying these changes?

It was suggested that the decentralization of manufacturing and of the service economy, each with its unique implications for rural areas and each roughly descriptive of the respective course of development in the two major categories of growing rural counties, seemed to underlie the growth in rural population. A third factor -- residential preference -- was introduced as a factor likely to be of importance in both categories of growing rural counties.

It is now necessary to spell out the future problems that might be created by the continued operation of these forces. Subsequently, broadband communications will be considered in terms of the role it might play in helping to resolve such problems and meet rural needs. In so doing, three major categories of rural counties will be considered:

- Turnaround Acceleration (service sector decentralization)
- Turnaround Reversal (manufacturing decentralization)
- Declining

Turnaround Acceleration Counties

Hansen characterizes "turnaround acceleration" nonmetropolitan counties as those which grew rapidly in the 1960's after having gained some populations in the 1950's (13-4). Typically, these counties are adjacent to or near metropolitan areas (13-32). They are further distinguished by growth in the non-goods producing, service sector of the economy.

Nature of change and its problems. On the surface, rapid growth and association with urban centers has been beneficial to the residents of this category of counties. Recently published analyses of the 1960's by the USDA's Economic Research Service confirm what other studies have found: economic "well-being" increases regularly as one moves from the most rural to the most urban parts of the country (15-64), and growing communities generally have "younger age structures, higher socioeconomic status, and higher labor force participation rates that suggest greater economic opportunity" (16-1).

It is not the purpose of this study to express judgment as to whether increasing urbanization has been as beneficial to the people concerned as these economic indicators might suggest. Nonetheless, assuming that a high level of rural growth of this kind is desirable, it is possible to distinguish associated developments that might hinder it in the future. Among these are: (1) the overload on community services created by rapid growth; and, (2) the heavy dependence of these areas upon the automobile and their consequent vulnerability to restrictions upon its use. On the other hand, if the assumption is made that rural development is desirable only to the extent that it contributes to preserving some degree of autonomy and independence, while still permitting rural people to share in the material benefits enjoyed by the population at large, then there might be some cause for concern about the basic and long-term effect of growth in this class of rural counties.

Turning first to the heavy demand that might be placed o[illegible]xisting community facilities, Beale believes that growth rates in a large number of rural areas already are sufficiently high to cause concern (7-3).

Although natural increase still is the primary cause of population growth in rural areas, 1970 Census statistics showed a direct relationship between rate of growth and net inmigration, with the most rapidly growing counties typically receiving the highest percentage of newcomers (16-2).

Besides the added burden on community facilities created by new residents, it also should be noted that the overall median age of population in growing rural counties is almost two years less than that of declining counties (implying more families of child-rearing age, and a greater requirement for schools) (16-8).

The second factor that might adversely affect further development of this class of rapidly growing nonmetropolitan counties is their heavy dependence upon unrestricted use of the automobile. Especially in the case of rural counties that make up extended "urban fields", gasoline rationing or high gasoline prices could have a catastrophic effect upon development and upon the lives of those already residing in the areas. The following description shows how extensive this dependence upon the automobile can be:

> "Just as the compact nineteenth-century city gave way to the metropolitan area, so todav the Standard Metropolitan Statistical Area (SMSA) is giving way to urban fields which may include whole regions within a two-hour driving radius of the central cities. Increased incomes, leisure, and accessibility have permitted a growing number of persons to avail themselves of opportunities and amenities throughout their respective urban fields. Thus, many persons who work in SMSA's may reside in nonmetropolitan areas where residential amenities are more agreeable, and many persons who live and work in SMSA's regularly go to nonmetropolitan areas for tourism, recreation, second homes, and retirement...Moreover, urban fields need not be limited to areas contiguous to SMSA's. Areas with attractive recreation-tourism-retirement-second-home features may expand because of demand generated by metropolitan residents who live well beyond commuting range" (13-160).

Finally, there remains the more speculative aspect of growth in rural communities that are part of urban fields -- that is, the possibility that the remaining independence and sense of community enjoyed by rural areas might become further submerged in the urban-rural sprawl of widely separated shopping malls and interstate highway-associated manufacturing plants. Thompson's description of the poverty pockets and social ills that have been a by-product of the process of metropolitan expansion is indicative of what might well occur in some rural sections of the geographically more extended category of urban fields:

> A growing population is accommodated, in part, by horizontal expansion, sweeping over the surrounding rural areas. Greater distances must then be traversed if any semblance of economic and social unity are to be preserved -- if, that is, the urban area is to be more than a collection of urban villagers in accidental proximity...*The poor have nearly always lived on the other side of the tracks, but the distances were short and contacts frequent, as in the schoolrooms and town halls. But the all-slum block becomes first the all-slum school, next the all-slum community -- the ghetto -- and threatens now to become the all-slum municipality.* What was once, if not benign, at least digestible *apartheid* at small scale portends on a larger scale unemployability, antisocial behavior, and, ultimately, recourse to even more centralization of authority. Slum schools that graduate unemployables and political enclaves of the poor that lack the tax base to support minimum public standards of health and safety invite either state or federal intervention...We are learning the lesson that a social structure, such as residential segregation by income, which may be viable at small scale is not necessarily viable at very large scale" (9-35/36). (Italics added)

While it cannot be predicted that urban fields will evolve in quite the manner described, the process at work in the development of urban fields bears some resemblance to that involved in metropolitan expansion, which was described by Thompson as follows:

> "New modes of transportation and communication permitted great cities to dominate small cities and other communities in their surrounding tributary area. These outlying communities, heretofore relatively autonomous, became subordinate to the metropolis and integrated with it. Hence, not cities in general, but metropolitan cities in particular dominate contemporary American society" (15-3).

The additional point to be made is that, however urban fields might evolve, the physical location and relative influence of service centers -- once established - are likely to be permanent in nature and self-perpetuating. As described by Thompson in explaining the historical dominance of cities, "factories come and go...a commercial bank (or similar service enterprise) that has efficiently served first a carriagemaker then an early automobile firm and then an airframe manufacturer (survives them all)" (9-15). In short, whatever inequalities come to be built into the evolution of the service sector in urban fields -- and it was suggested that some rural sections might be bypassed entirely -- they could become lasting.

Alternative course of development. Communication systems, as with any other element of a community's infrastructure, are likely to be functional and viable to the extent that they mesh with the dominant needs and activities of that community. In rapidly growing nonmetropolitan counties, as we have seen, the dominant economic activity is that involving the growth of the service sector. Thus, while this category of county might come to experience the overload on community facilities which comes with rapid growth, and could benefit from the related public broadband services described in Chapter II, their future is likely to be most affected by the pattern in which this service sector evolves. Therefore, the effect which commercial broadband services might have upon this evolution is of most concern.

Nonetheless, it is not enough to know that the broadband services most important to the development of these counties might be the commercial services described in Chapter II. There also has to be some understanding of the purpose and function they might serve, which, in the case of this rapidly growing category, might be in helping to preserve some of the existing small towns and as well as helping to enable a more equal sharing of the prosperity of the larger region. However, since we are dealing with the future utility of broadband systems, it is necessary to have some idea as to how such counties might counter the future dislocating effects of growth in the urban field. Thus, in the case of these counties, as well with the Turnaround Reversal and Declining categories to be considered later, an alternative course of development will first be hypothesized and then the contribution that broadband systems might make to furthering this course of development will be considered.

It was earlier suggested that there might be an uneven sharing of benefits in urban fields, with some rural areas bypassed and others becoming isolated dumping grounds for the poor and untrained. At minimum, the growth of large-scale regional shopping centers and service industries widely separated and linked by high speed highways, could lead to the demise of rural communities as surely as have the previous encroachment of subdivisions and the other elements of suburban sprawl.

Thompson suggests an alternative that is a compromise to the very large-scale regionalization of the urban fields, one which "emulates" the features of large metropolitan areas while still preserving the identity and prosperity of the smaller places in it. Scaling down the size of towns described by Thompson and substituting rural communities for the small urban areas referred to, it does represent one alternative course of development that could prove less dislocating and disruptive to the inhabitants of this category of rapidly growing rural counties:

> "The small urban area might, instead or in addition, simulate greater scale. A number of small- and medium-size urban areas, connected by good highways and/or rail lines may form a loose network of interrelated labor markets. With widespread ownership of automobiles and a well-developed bus system on expressways permitting average speeds of 50 miles an hour, the effective local labor market would extend radially for 25 to 30 miles around one of the larger urban places. A couple of small cities of, say, 25,000 population, with two or three main industries each, plus a half-dozen small one- or two-industry towns of half that size add up to a 100,000 to 200,000 population.
>
> The local labor market could then achieve the scale necessary to offer the counseling and teaching so critical in our rapidly changing economy. Area industrial development efforts could be coordinated, including common research and industrial parks. In North Carolina, a state filled with small- and medium-size urban areas, a research and development triangle has been created in the Chapel Hill-Durham-Raleigh area, which is 15 to 30 miles on a side and encloses about a quarter of a million people.
>
> In such complexes, both public and private investments could be planned strategically. Instead of many small, bare community halls sprinkled across the area, one spacious, acoustically pleasing auditorium could be built. In place of a couple of two-year community colleges staffed as extensions of the local high schools, a strong four-year college could be supported. Nearby and inexpensive higher education -- commuter colleges -- may be critical in holding the area's talented young from middle- and low-income homes, and perhaps in attracting those families in the first place. Again, museums, professional athletic teams, complete medical facilities, and other accoutrements of modern urban life could be supported collectively..." (9-27).

Role of broadband communications. Whether the availability of broadband systems will enable greater decentralization of service industries and more even growth within an urban field remains to be demonstrated. Leaving to Chapter IV the discussion of how such systems in practice could be developed, the task at hand will be to consider whether broadband systems might enable the kind of decentralization contemplated in the model presented above.

On the general subject of decentralization, the National Academy of Engineering (NAE) report on "Communications Technology for Urban Improvement," stated that "the viability of (rural decentralization) is enhanced by the transition of the United States economy from a manufacturing to a service economy. It is the service sector...which is expected to make the greatest use of telecommunications" (17-171).

Also cited in the NAE report was a British government report on the establishment of the "Green Belt" around London which concluded that "...the main factor deterring business and industrial decentralization has been the reduced operating efficiency due to the absence of fully adequate communications facilities" (17-173).

To some extent, the cited barrier of inadequate communications apparently has already been breached, as shown by movement of corporate headquarters from cities to suburbs:

> "What began as a minor movement in the middle 1960's has become, by 1971, a mass exodus whose true dimensions are beginning to be visible in only one central city, New York, where the concentration of economic activities at the center is greatest. In 1965, New York City was the home office for more than 125 of top industrial companies in the United States. By 1971, at least 24 of these companies

> had decided to leave New York City for the surrounding suburbs, mainly in New Jersey and Connecticut. Although the decentralization of office employment seems most advanced in New York, other cities such as Detroit, St. Louis, Philadelphia, Baltimore, Houston, Atlanta, and Los Angeles are beginning to experience corporate moves to their suburban rings that rival the outward movement of bluecollar employment in the 1950's.
>
> Private corporations are not the only example of large national organizations that are electing to leave the central city for the suburbs. In the Washington, D.C. area, for example, where the Federal Government is the largest employer, major government offices have been moved out of the city in recent years, and for much the same reasons that affect private decision making in the area of location policy. Among the agencies that have emigrated are the National Bureau of Standards, the Atomic Energy Commission, the Geological Survey, the Bureau of the Census, the National Institutes of Health, the Navy Department, the Central Intelligence Agency, and the Weather Bureau" (18-463).

Neil Gold, in a research report for the U.S. Commission on Population Growth and the American future, identified advances in communications technologies as being one of the principle factors enabling this corporate decentralization. According to Gold, "as the effects of this technology began to be widely understood in the middle 1960's, a segment of corporate leadership concluded that the economic, social, and psychological benefits that would result from relocating their headquarters in the suburbs were an effective counterweight against the loss of physical proximity and the daily visual contacts characteristic of doing business in the urban core" (18-463).

The NAE report cited earlier takes Gold's point a step further by arguing that "the inventions have already been made to permit the design of special communications systems which will allow these (service) activities to be conducted...in small communities scattered throughout the nation" (17-170). In the judgment of another British study group cited in the NAE report, the specific usages of broadband communications in linking widely separated operations are likely to include "graphic display, rapid facsimile, computer and data access, conferencing..." (17-173).

Concerning the application of the innovations, the most definitive experimental indication of feasibility is likely to come from the HUD-funded "New Rural Society" study now being conducted by Dr. Peter C. Goldmark.

While the New Rural Society project, when completed, could furnish hard evidence on the practicality of decentralizing service sector activities to rural areas, there is some question as to whether the rural area of Connecticut being studied is comparable in terms of economic characteristics to the rapidly growing nonmetropolitan counties considered to be typical of the category of urban fields. In other words, it might be that the New Rural Society project will be most useful in indicating the role of broadband communications in rural areas just beginning their turnaround from a state of decline (see below).

Summing up, based upon a theoretical understanding of the value of broadband communications systems in facilitating the decentralization of the service sector, broadband systems could contribute to rural development and could enable greater dispersal of industries throughout an urban field. Like the chicken and the egg, however, the broadband services involved will not be offered until proved economic -- and they will not be proven economic until integrated into an actual system. On the assumption that knowledge as to value and feasibility might attract potential system operators and break the chicken-egg cycle, Chapter IV will examine how commercial broadband services might pay their own way in a full service, area-coverage system.

Turnaround Reversal Counties

This section will address that category of nonmetropolitan counties whose growth has been most associated with an increase in manufacturing employment. Unlike the faster growing Turnaround Acceleration group just discussed, counties in this category do not tend to be located in close proximity to metropolitan areas. As the term implies, "Turnaround Reversal" are counties in transition that have recently emerged from a period of decline. Hansen includes in this group those counties that gained population in the 1960's after having lost population in the 1950's (13-4).

Nature of rural change and its problems. As outlined earlier, the view is still common that the type of manufacturing plant likely to relocate to rural areas will be of the slow growth, low technology sort that is unlikely to stimulate further development or otherwise improve the economic base of the host area. By contrast, it was shown that actual samplings of new industry locations in rural areas reflected a far more diverse industry mix than the "urban cast-off" theory might suggest. As described by Claude Haren, many industries located in rural areas in the 1960's were of the kind previously associated with urban areas and included a sizable number producing machinery and industrial components of all kinds (11-433).

Although there were rural areas in the 1960's, particularly in Appalachia and the Ozarks, where employment grew primarily as a result of the relocation of apparel and other low technology industries, there also was evidence of relatively depressed rural areas moving up the ladder of industrial diversification. Hansen described this process as follows:

> "...the process of industrial filtering does eventually lead to the upgrading of both manpower qualifications, types of industry, and incomes. These phenomena are clearly in evidence in the South. The industrialization of the South was initiated in large measure by the movement of textile mills from New England and other northern areas into the Piedmont region of the central Carolinas. The textile mills in turn generated other activities. For example, by 1970 there were 214 establishments in the South producing machinery for the textile industry. In addition, there were 65 chemical plants involved in producing synthetic fibers; the bulk of these plants were in the states where substantial textile production has concentrated. Suppliers of dyes and other processing chemicals were also stimulated by the movement of the textile industry. The growth of manufacturing in the Carolinas, especially North Carolina, was followed by similar expansion into Georgia. Decentralization next spread to the Tennessee Valley, which has managed to achieve a higher degree of industrial diversification than either the Carolinas or Georgia. More recently, the states of Mississippi and Arkansas have entered the lower rungs of the filtering process" (13-163).

Although detailed statistics do not exist for the specific class of Turnaround Reversal counties being discussed here, it can be inferred that growth in manufacturing employment probably has had a beneficial effect. While some net outmigration is still taking place in some of these counties, the headlong exodus that characterized earlier days has been at least arrested. Referring to the USDA analysis cited earlier in the discussion of Turnaround Acceleration counties, these counties are likely to have shared in the general attributes of growing rural areas, which were found to be favorable in terms of income, age distribution, and labor force participation. In the meantime, these manufacturing-growth related counties typically have not been burdened with a heavy influx of new residents, despite the fact that new jobs in the 1970's were being created at a rate well above the national average.

In these counties, it is not the present, but rather the long-term outlook that might be of concern. And it is the long-term ability of these counties to share in the growth of the service sector that is coming to dominate our national economy, that is open to question. Even granting that life in these counties will remain attractive to the extent that change is slow and the population stable, can these communities preserve their relative share of the nation's material goods while depending upon manufacturing for employment? Or, must the 'move in order to stand still': i.e., must there be some growth in service sector industries if they are not to be confined to a constant share of the diminishing sector that is manufacturing employment in this country?

To this point, Claude Haren, in a study of rural industrialization in the 1960's, offers evidence which suggests that growth in the service sector has not necessarily accompanied or followed an increase in manufacturing employment:

> "In accordance with national trends, *changes in the service-producing groups, particularly at the local or small-area level, not only diverged from but often ran counter to shifts in manufacturing and other goods-producing industries.* In some instances the lack of a more substantive increase in nonbasic employment was attributable to the well-developed system of shopping facilities, hospitals, schools, and so on, already available either in the immediate or adjoining community, or at a regional service center. The retention of purchasing and related functions at corporate headquarters and similar trade leakages or complete or partial tax abatement often seriously delayed the accumulation

> of investment capital and fiscal resources required to underwrite much-needed improvements in community and business services and facilities. All too typically, a high proportion of increased payrolls went to nonresidents, or added work opportunities resulted in the substitution of local employment for jobs formerly held outside the immediate area" (11-434). (Italics added)

Beale, in another study of patterns of growth, found that "...the business functions of many very small towns have diminished even though the housing function has not" (20-35). Beale concluded that these small towns have been sustained only through extensive commuting of their residents to those larger centers that picked up the business and service facilities formerly located in the small towns.

Alternative course of development. It was suggested earlier in the discussion of Turnaround Acceleration counties that communications systems, like any other element of a community's infrastructure, are likely to be functional and economic only to the extent that they mesh with the dominant activity in that community.

Since the counties now being discussed are manufacturing-centered in their growth and tend not to be located in close proximity to metropolitan areas, it would be unrealistic to expect that the establishment of broadband communications systems, in and of themselves, would lead to the burgeoning growth of service industries that was found in Turnaround Acceleration counties.

Absent those other conditions that enable significant growth of the service sector, among which is association with dynamic metropolitan areas or the hybrid urban fields, the most that probably could be accomplished for the present is to forestall further erosion of existing service industries in these communities, enabling their subsequent expansion when economic conditions permit.

Concerning the non-economic stimulus to development in those counties, the potential seems clearer. Although attractiveness to the retired and semi-retired will vary dependent upon geographic location, many counties could capitalize upon the growing desire and ability of urban dwellers to live in the country. To do so, however, it seems likely that these counties would have to be able to offer a reasonable standard of community amenities and facilities. As pointed out earlier, the possible stake in attracting this segment of the urban population is sizable and growing: so-called rural "retirement" counties have been the most rapidly growing class of rural counties thus far in the 1970's and now account for a total population of 8.7 million in 377 separate counties.

Role of broadband communications. Although service sector need for and use of broadband communications are not likely to form the leading stimulus to the establishment of broadband systems in these manufacturing growth-related counties, still, as will be discussed in Chapter IV, any broadband system, if it is to be feasible for area-wide rural coverage, presupposes its full use for both public and commercial services. While dedicated commercial links are not likely in these counties and while the use of cable channels will be less intensive than in their more rapidly growing counterparts, the broadband system at least can be in place -- and available for increased and more extensive business and commercial use should the need arise. In the meantime, the basic system, in the manner to be described in Chapter IV, could be built and paid for on the basis of providing those entertainment and public service uses described in the second chapter of this report. In the latter uses, these systems could help to provide that improvement in public services necessary to retain existing population as well as to help attract the retired and semi-retired.

Declining Counties

The reversal of migration from rural areas and the relative increase in employment in rural versus urban areas has not been shared by all rural areas.

Although the number of nonmetropolitan counties losing population has decreased from approximately 1,300 in the 1960's to 600 in the period 1970-73, the 600 losing population represent 25 percent of all rural counties and encompass sizable areas of the Great Plains western Corn Belt, southern Appalachian coal areas, and the old Cotton Belt (21-30).

Nature of rural change and its problems. Declining counties tend to be those in which gains in manufacturing and service employment have not counter-balanced losses in the mining and agricultural sectors. Of great importance to the future of these counties is the exodus of working age residents and the steep increase in the proportion of the elderly and the young: in 1970, the median age of the population in declining counties was almost three years greater than that in growing counties (16-40), and Beale has identified 80 declining counties in which the median age has exceeded 40 years (20-24).

Decline, in many instances, has tended to feed upon itself. As pointed out by Brown, the great majority of counties that lost population in the 1970-73 period also lost during the 1960's (16-23). Beale describes how the process of decline can be self-perpetuating:

> "The important point is that any community reaching this condition is certain to be characterized by an unusually high degree of influence by the elderly on community government, by disproportionate problems of providing housing and services for the elderly, and by a scarcity of young able-bodied labor force or potential future labor force. The latter two problems may be aggravated if the population density is sparse and the typical government units are small, as is commonly the case in the Plains. It is not impossible to break the momentum of such a trend, but the condition apparently tends to feed on itself. What psychological support and incentive does a young adult have to remain in a community where the overwhelming majority of his peers and siblings have left or are about to leave? There is almost the force of a *deus ex machina* needed to break the cycle" (20-24).

At the same time that the severity of these problems should be understood, it should also be recognized that not all rural counties in this category are experiencing the same rate of decline, and all are not in the predicament described above. Concerning the rate of decline for example, a majority of rural counties losing population in the 1960's lost less than 10 percent over the course of the decade (16-37).

As will be further discussed below, the range of population decline, relative economic opportunity, and state of community facilities vary greatly among counties in the declining category. As the needs of individual counties vary, so too will the utility and configuration of the broadband systems that might serve them.

Alternative course of development (modest change counties). In the view of Hansen and Brown, some rural counties have been able to successfully adapt to a decline in population and remain viable places in which to live (13-17; 16-23). Others by contrast, have experienced a degree of deterioration in community services that has been as severe as their drop in population.

In considering the course of rural development and the possible role of broadband communications in declining areas, therefore, some account should be taken of the differing degrees of change that might be entailed in reversing or arresting decline in these areas. To preserve some sort of rough distinction in the discussion that follows, declining counties will be grouped under the headings of "modest change" and "major change". Those in which development might entail a modest degree of change will be considered first.

Hansen's analysis of some rural counties of the Great Plains reveals an apparent paradox: the same areas that generally experienced heavy population losses for several decades also ranked first in the country in terms of rate of increase in income, "...rising from an annual rate of change of 2.9 percent in the 1950's to 6.2 percent in the 1960's (13-17).

Brown, in a USDA study of growing and declining counties, stated that "...one cannot conclude that...all declining areas are being bypassed by the process of national economic growth." Population decline, in Brown's view, may not only be transitory, but also "...may reflect a period of adjustment in the manpower needs of agriculture, forestry, mining, and other extractive industries" (16-23).

Does the evidence indicate that the residents remaining behind in some declining areas can maintain a tolerable level of economic activity and standard of living? Hansen thinks it does:

> "...it is difficult to compare the situation in the Great Plains, the Upper Great Lakes, northern New England and other relatively prosperous areas having heavy outmigration with the situation in areas such as central Appalachia, South Texas, the southern Atlantic Coastal Plains, and the Mississippi Delta. In the Great Plains, for example, outmigrants have generally been well prepared to take advantage of economic opportunities in other areas. Of course, the population left behind has a relatively high proportion of older people and it is often difficult to maintain essential services for a widely dispersed population. On the other hand, agriculture is viable and there is relatively little poverty. In addition to savings and farm income there is considerable income from the Federal government in the form of farm subsidies and Social Security benefits. There also are viable small towns, although they probably should be developed as service centers for rural hinterlands rather than as "growth centers" capable of halting and even reversing outmigration. Economic theory maintains that outmigration should raise the value of the marginal product of the remaining labor force, other things being equal. This is because each of the remaining workers has more of the non-labor resources of a given area with which to work. And, in fact, the evidence indicates that population adjustments in the Great Plains reflect successful adaptations not only for outmigrants but also for the people left behind. The greatest acceleration of nonmetropolitan income in the country has taken place in the Great Plains, rising from an annual rate of change of 2.9 percent in the 1950's to 6.2 percent in the 1960's (13-17).

Whether or not these areas of the Great Plains will ever achieve rapid growth or industrialization -- and their geographic isolation from urban areas suggests they may not -- it is important to note that population decline apparently has tended to keep pace with the reduction in job opportunities. This implies that some rough degree of equilibrium has been struck. The population remaining behind apparently has been able to support schools and other community facilities which, while slimmed-down, still are of sufficient quality to prepare those who must someday depart for other regions to find jobs -- and still provide a satisfactory level of public services for those who stay.

At least as compared with the category of counties that will be discussed next, the public services and educational systems in these areas probably have not deteriorated to the point at which they are either inadequate to their purpose or incapable of being supported at an effective level by local taxpayers. If this apparent equilibrium between community resources and jobs on the one hand and resident population on the other, can be maintained, and if public facilities can be updated, then these rural areas probably will remain attractive places in which to live. To the extent that these rural counties are also able to remain effectively integrated into the agricultural sector of the economy that they serve, they are likely to manifest a degree of stability and independence that certainly is among the underlying objectives of rural development.

Role of broadband communications (modest change counties). In many respects, the kind of broadband communications system that would be appropriate to these "modest change" counties would be quite similar to that described in the previous discussion of Turnaround Reversal counties.

Like Turnaround Reversal counites, these counties apparently possess school systems and other community services that are functioning effectively and that presumably are in a position to benefit from the kind of incremental qualitative improvements that the addition of broadband services alone might bring. Unlike the next category of declining counties to be discussed, there are not likely to be more basic and higher priority needs to be first addressed, such as replacing decrepit school buildings to house children or finding the necessary funds to hire competent teachers. In other words, if Hansen and others are correct in their description of the viability of this category of declining counties, upgrading of community services need not first require a basic rebuilding of facilities, and improvements are more likely to be capable of being initiated without massive outside assistance and financing. Further, these counties seem likely to have retained that sense of community involvement and tradition of working together which makes it more likely that they could on their own initiate and carry through to fruition local broadband communications projects.

The kind of broadband system appropriate to the "equilibrium" counties being discussed in this section thus might be public services oriented and capable of being underwritten in part by the school systems and local governments that would share in their use. Until population decline levels off and these counties long-range economic prospects become reasonable clear, however, it seems likely that the incentive for business and commercial use of these systems would remain limited, except in those very active agriculture areas where such enterprises as grain elevators, commodity trading firms, and livestock auctions might lease system time.

Alternative course of development (major change counties). This category of declining rural counties represents those areas where need is the greatest in every category of community service. In these areas, there is not a balance between the community's resources and the needs of those who have remained. While tax revenues and resources of every kind have tended to shrink, the need for them has not, and major deterioration of these communities has been the result.

Recognition of the severity of such problems in rural areas and the approach taken by Congress in helping to resolve these problems were described as follows by Senator Humphrey in 1973:

> "We know that the highest rates of unemployment in America were in the countryside. We know that two-thirds of all the substandard housing and half of the poverty were out there in rural America. We also learned that these people were not receiving a fair share of the assistance provided by the Federal Government.
>
> What we hoped to do through the Rural Development Act was to provide economic opportunity -- jobs. *But we know that before industries and business can spring up in small towns there has to be a certain infrastructure -- a broad combination of community facilities* that all add up to improving the general quality of life so that money will flow in and people will stop moving out" (22-12). (Italics added)

By themselves, of course, improved community facilities are not likely to be of sufficient weight to influence a firm to locate its plant in a given rural area. In a USDA-funded study of 39 selected branch plants established in rural areas of the Upper Great Lakes in the 1960's, location of raw materials, major markets, and relative distance to headquarters and other branches were described to be of greatest importance in determining general location of new plants.

Once general location of a new plant was determined, however, the individual attributes of different areas did come into play. First in order of attributed importance in the USDA-funded survey was the availability of trainable labor:

> "Officials of 24 companies discussed labor, most emphasizing that a community must demonstrate that it has an adequate supply of trainable labor in the area, otherwise it has little chance of getting a branch plant...Four firms were strongly influenced in their decisions by the presence of vocational schools where the needed skills were being taught, or training programs were being provided" (23-2).

An official of the Corning Glass Corporation, which decided in the 1960's to locate most new plants in communities of 10,000-20,000 in population, put the matter even more strongly:

> "As you can imagine, the specifications for the manufacturing of today's products continue to get tighter and tighter. This seems to be the case whether you are making toys or computers. Also, the technology to produce many of today's items means that a work force that is hired to man today's plants must be able to offer his prospective employer either a greater degree of educational background or a greater capability of being trained than has been the case of his predecessor. We, in our business, are no exception to this situation. Personnel from our search teams will, in nearly all cases, talk to employers in a community and raise the question of the trainability of the people available in the area" (24-7).

Although the Corning Glass official cited a broad range of community facilities as being important in site selection, it is interesting to note that the 39 companies interviewed in the USDA-funded project seemed to give little weight to, or ignore, many categories of community services:

> "Local police and fire protection seemed to be taken for granted by companies moving into non-metropolitan communities.
>
> Very few company executives mentioned medical, dental, and hospital services as influencing branch location decisions.
>
> Only when the establishment of the new plant required the relocation of a number of supervisory personnel or skilled workers were company officials influenced by the availability and quality of schools, churches, social and recreational activities" (23-3/4).

Taken at their face value, these comments seem to indicate that a rural community can get by with very little in the way of community facilities and still successfully compete for new industry. However, when it is realized that an educated, trainable labor force implies the existence of a functioning community, then the quality of the full range of community facilities takes on a greater significance.

In the same connection, with only a few exceptions, the 39 corporations interviewed in the USDA study stated that the successful communities had sought them out, and all successful communities were found to have an active Chamber of Commerce or industrial development group:

> "The real selling job was done in a face-to-face presentation by an action committee of the Chamber of Commerce or by the industrial development corporation. They usually presented community statistics and pertinent information applicable to the particular prospect, probably a profile of the industrial park, and photographs of what the community had to offer" (23-9).

Suffice to say, moribund rural areas, or those with little more than a labor supply, are not likely to produce this kind of active community involvement or initiative. Finally, it is important to note that plant location usually is a competitive process among many communities. Whether a community with serious deficiencies in the availability of medical services, shipping facilities, school system, or fire and police protection, can win out is at least open to doubt. That corporations, in the words of the Corning Glass official, consider site selection to be a competitive process seems clear:

> "In the end, all the parts of the industrial development effort must add up to make a given community the most desirable when measured against other like communities due to the competition for new plants -- and there will be competition" (24-13).

Role of broadband communications (major change counties). In the case of declining rural counties, the feasibility of broadband systems is likely to be dependent upon the basic decision that is made by federal and state government concerning the rebuilding of community facilities, including the schools and health services. If a commitment is made to improve the quality of these services in a major way, then it is possible to visualize how the related broadband services described in Chapter II might play a useful and cost-effective role in their delivery. In this instance, should the benefits of broadband so warrant, some of the funds provided for the major rebuilding programs could be used to help underwrite the cost of the broadband system.

If such a commitment is not forthcoming, however, the outlook for feasibility is poor. Unlike the growth areas discussed earlier, community facilities in these counties are likely to have deteriorated to the point at which the provision of the most basic services is in jeopardy. Caught between shrinking tax revenues and an increased demand for assistance from the elderly and the unemployable, these communities are unlikely to be able to spend scarce tax dollars on the improvements that broadband services might provide when, at the same time, they are struggling to maintain the most minimal basic level of health, education, and other community services.

If, as will be discussed in Chapter IV, the economic feasibility of rural broadband systems depends upon the fullest possible use of community services as a revenue source, then it follows that the systems themselves are not likely to be feasible until (1) the communities on their own somehow become economically revitalized or (2) direct government subsidies are made available for major community service rebuilding programs (and related broadband delivery services).

In the laissez-faire alternative, broadband systems are likely to come along, if at all, only when a rural area has somehow brought its resources and population into balance along the lines of Hansen's Great Plains example or until it has moved up the ladder of industrial diversification as have many counties in the South.

When and if one of these stages have been reached, broadband communications, as discussed in the cases of Turnaround Acceleration and Turnaround Reversal counties, could perhaps assist in the growth and preservation of service industries and they could improve the quality of community facilities so as to attract such people as retirees. But in this instance the development of broadband systems still would have to await the economic evolution of the areas in question; broadband systems, in and of themselves, would not have been an active agent of change.

In the second alternative of direct subsidies and other assistance to upgrade community facilities, it is difficult to visualize a realistic source of funds except that of federal and state government. If this is the case, then the value as well as the feasibility of broadband systems is likely to be dependent upon the extent to which they mesh with and contribute to the objectives of such federal and state assistance programs. In turn, concerning those objectives that the broadband services must mesh with, it is necessary to consider the future course of rural development policy generally.

As an example, should funds be simply allocated so as to preserve existing community facilities in all areas at some minimum maintenance level, then it is unlikely, for the reasons outlined above, that any will be able to support the costs of broadband systems.

On the other hand, if governmental policy decisions are made to focus resources in a more selective manner which would create growth centers, for example, then it is somewhat easier to visualize how broadband communications systems could make an active, and perhaps significant, contribution.

One of the features of the growth center approach is that it attempts to work with, rather than against, the economic forces that determine the viability of a rural community. The Council for Agrilcultural Science and Technology offered the following observations in this regard:

> "Some communities do not have the critical labor supply, transportation, and opportunities for low-cost provision of adequate services necessary to sustain growth. They will require outmigration or commuting to work in other communities. A rural development program cannot be expected to save every rural community in trouble...Resources for planning and implementation of programs may be employed most effectively if they are concentrated in those areas where the need is greatest and where population, trading, commuting, and infrastructure patterns provide a critical scale of labor and other services needed to alleviate problems and constitute a viable economic entity...

Voicing a similar view on the revitalization of rural areas, an official of the Economic Development Administration has suggested that Federal efforts be focused on developing at least one viable center in each state "development district". In so doing, a functional test was proposed in which relative economic advantage, such as key transportation, trade and service links to surrounding areas, would be given strong weight (26-61).

Taking this functional approach a step further in a study of historical growth patterns in the United States, Hugh Denney found that areas approximately 64 miles in radius seem to be evolving as prime regional centers. Applying this discovery to the state of Missouri, Denney found such centers not only to be major trading centers but also increasingly central locations for television broadcasting, junior college and higher education, as well as medical facilities (27-27).

Relating this concept to the way in which governmental resources might be allocated, Denney suggests that 64-mile radius centers be a focal point for action:

> "A national policy to raise the levels of transportation, communications, health, and education on the (64-mile radius) spatial pattern would bring all parts of this country within one hour of such services and create a healthier environment for industrial dispersion" (27-107).

Specifically, Denney identified 296 such centers in the United States which are below the national average in the ratio of community service employees to population:

> "It is in these communities that special efforts are needed to improve services whenever the population based will support them...
>
> Most centers on (this) scale are devoting their energies to securing industries; a commendable cause, but they are often giving inadequate attention to making their communities good service centers for the population they now have. Most industries are looking for towns that have a high level of services, thus these communities would do well to raise their levels of service while continuing to work for improved industrial jobs" (27-116).

While Denney's 64-mile radius growth centers are to be found in all areas of the country, his theory offers one possible rationale for locating government offices and allocating developmental efforts in declining rural areas. It is of further and special interest that potential regional growth centers of this size might represent good market sizes for broadband communications: in 1968, 243 of 352 64-mile radius centers were found to be served by cable television (27-56).

To briefly sum up this discussion of the role of broadband communications in furthering the development of declining rural areas, it can be seen that the outlook for such systems is decidedly uncertain and dependent upon the future course of government policy on rural development. Unlike the situation in the growth counties considered earlier, broadband systems in these counties cannot simply be incorporated into, or underwritten by, existing community services. Although any or all of the public broadband services described in Chapter II could be of substantial value in declining counties, their feasibility will depend upon the 'how, where, and how much' of federal and state assistance efforts.

Should this investment be sufficient to result in a major improvement in community services, broadband systems conceivably could be used to extend health, education, and other governmental services to the majority of the rural populations involved. In turn, revenue from the sponsoring government agencies might make a critical difference in helping to underwrite the broadband systems themselves. If not, then the most hard-pressed of the declining rural counties will probably have to await that uncertain day when growth creates sufficient economic prosperity so as to enable the establishment of strictly locally-supported and financed broadband systems.

Summary And Discussion Of Findings

In approaching the task of examining the contribution broadband communications can make to rural development, it first was necessary to examine the present nature of change in rural America.

The 1970's has seen a reversal of the historic migration of Americans from rural to urban areas, with a net 1.6 million persons moving from urban to rural areas. In this period, overall rural growth (5.6%) exceeded that in urban areas (4%). This growth was not distributed evenly among all rural areas, nor was it found to be explainable simply in terms of proximity to metropolitan areas: the largest quantitative increase in net inmigration occurred in counties adjacent to metropolitan areas, but the sharpest turnaround in migration developed in the more distant rural counties.

This change, whatever else it might have done, has not altered the sizable differences that exist among rural areas. Parallel with the finding that there is no simple way to describe rural America is this study's proposition that broadband communications systems will succeed or fail to the degree that their characteristics match the particular needs and economic conditions of each rural area in which they are located.

In trying to make sense of the great diversity of needs and conditions in rural America, this study first identified the major forces underlying present change and then projected the future course of development and indicated needs that are likely to emerge as a result of these forces.

The three principal forces identified in this study were:

- decentralization of manufacturing
- decentralization of the service sector of the economy
- residential preference

Decentralization of the service sector of the economy and of manufacturing were found to be roughly descriptive of development, respectively, in two major categories of growing rural counties: "Turnaround Acceleration" (generally adjacent to metro areas) and "Turnaround Reversal" (generally not adjacent to metro areas). A third major factor -- residential preference -- was found to be important in both. In the following summary of the points that were made concerning these two categories of growing counties (plus, for completeness, a third category of counties that are declining), future needs are related to the contribution that broadband systems might make.

Turnaround Acceleration Counties

This group of counties grew rapidly in the 1960's after having gained some population in 1950's. As a class, they are distinguished by their proximity to metropolitan areas and their relative growth in the service sector of the economy.

Two of the problems those counties might encounter in the future are:

- an overload on existing community facilities. 473 counties grew by 10 percent or more between 1970-74, with some achieving an annual growth rate of 22.5 percent or more; the fastest growing were also characterized by an influx of new residents and a higher proportion of families of child-rearing age.

- effects of fuel shortages upon automobile use. Many of the fastest growing counties are in hybrid urban-rural areas that have evolved as a result of extensive long-distance commuting (up to two-hour radii of travel). High gasoline prices or rationing could have a catastrophic effect upon continued growth in these counites.

A third problem this category of counties -- especially those located in those sprawling hybrids called "urban fields" -- might encounter in the future is uneven development and uneven sharing in the fruits of growth. It was suggested that the 'leap-frogging' expansion process entailed in the development of urban fields could leave isolated backwaters in which "all slum municipalities" might become the successor to what were, in the superseded small rural communities, all-slum blocks or neighborhoods. Concerning the dominant growth activity in these counties -- which was found to be in the non-goods producing, service sector of the economy -- the prospect was offered of the centralization of such enterprises at a few key locations along Interstate Highways and other high-speed arteries.

As an alternative to this very extensive, scattershot kind of regionalization, a smaller scale variant was discussed in which development might be more evenly dispersed throughout the rural areas. In this alternative, the rural region might "emulate" the extensive regionalization of the larger urban field before the latter becomes firmly established.

In this regard, one of the contributions broadband communications might make would be to enable such "emulation" by substituting communications for that of travel by car. Specifically concerning the decentralization of service activities, there is recent evidence of the key role played by communications in making possible the decentralization of corporate headquarters. In addition, it has been shown that communications has enabled the decentralization of precisely the kind of service activities that have been found to dominate the development of urban fields. Because distance is no barrier to communications once links are in place, broadband systems might enable greater dispersal of service industries throughout a growing rural region as has occurred between city and distant suburbs in the New York metropolitan region. At the very least, the existence of broadband systems in a rural area would mean that the ability of that area to share in the subsequent development of the larger region would not be foreclosed.

As will be discussed in Chapter IV, broadband systems offering the entertainment and public services decribed in Chapter II could be economically feasible and could be established while an area was still predominantly rural in character. Once in place, however, the system could be subsequently expanded to provide those commercial broadband services that could enable the more dispersed decentralization of economic activities suggested above.

Turnaround Reversal Counties

The dominant economic force in this category of counties is increase in manufacturing employment. Unlike the faster-growing Turnaround Acceleration group, counties in this category tend not to be located in close proximity to metropolitan areas. As the term implies, "Turnaround Reversal" are counties in transition, having emerged in the 1960's from a lengthy period of decline.

For the present, the effect of the growth of manufacturing in this category of counties probably has been beneficial to the inhabitants involved:

- while some net outmigration is still occurring in some of these counties, the major exodus and attendant dislocation of earlier days has been arrested.

- new jobs have been created, but characteristically there has tended not to have been a large influx of new residents which might over-burden existing community facilities.

- even if new manufacturing jobs have been created by the establishment of slow-growth, low technology industry (as discussed earlier, actual samplings show this not necessarily to be the case in rural areas), there are numerous examples, especially in the South, where low technology industry has been succeeded by progressively more growth-generating kinds of enterprises.

In these counties, it is the long-term economic outlook that could be of the greatest concern: i.e., their ability to share in the growth of the service sector that is coming to dominate our national economy. The operative question is whether they can preserve their relative share of the nation's material goods while still relying for employment upon that diminishing sector of the economy which is manufacturing in this country.

Studies of rural industrialization have shown that growth in the service sector does not necessarily accompany or follow an increase in manufacturing employment. In fact, it was found that in the 1960's manufacturing-induced growth frequently ran counter to growth in the service sector. Concerning rural small towns, generally business activities have tended to decline and become progressively centered in larger communities.

While broadband systems by themselves are not likely to be a factor stimulating decentralization and growth in the service sector in the manner in which they might in the case of Turnaround Acceleration counties, some capability for service sector usage will be available in any two-way broadband system that might be established. Although the feasibility of systems in these Turnaround Reversal counties will be primarily dependent upon their usage for entertainment and public services, the population of these counties should be in a good position to be able to afford the latter. They are not as likely to have had an increase in tax revenues resulting from new industries counterbalanced by increased demands for services generated by an influx of new residents. Thus, it might be likely that some portion of system cost could be underwritten by public services users such as the school system. Additionally, disposable income in these growing counties is likely to be sufficiently high that many individual subscribers could afford to pay for hook-up to the system.

Provided that broadband systems can be justified on the above grounds (a matter dealt with in greater detail in Chapter IV), the additional availability of the system for broadband commercial services could serve the purpose of:

- helping to forestall the further erosion of the existing service sector in these counties.
- providing the communities involved with the communications infrastructure necessary for the growth of the service sector, when the latter occurs.

Declining Counties

Although the number of rural counties losing population decreased by more than half in the early 1970's, 25 percent of all rural counties in the United States still remain in this category.

As a class, these counties are those in which gains in manufacturing and service employment have not counterbalanced losses in agriculture and mining jobs. In these counties, the departure of working age residents has led to a steep increase in the proportion of the elderly and the young. The need for public services, such as those described in Chapter II, has tended to escalate as tax revenues have shrunk.

For the most seriously affected of these counties, it is open to serious question whether broadband systems would be feasible unless subsidized in their public service applications by federal or state government. This is likely to be so, as will be discussed in Chapter IV, because the financial viability of these systems in large part will depend upon community services, such as the schools, an important source of revenue. If the communities in question are hard-pressed, it is unlikely they will be able to spend scarce dollars on the improvements that broadband services might bring while at the same time they still might be struggling to maintain the most minimal basic level of health, education, and other community services. On the other hand, should a federal or state decision be made to improve these community services in a major way, then their delivery by broadband might be a cost-effective method and might warrant federal or state sharing in their costs.

In the category of declining rural counties, therefore, the feasibility of broadband systems is likely to be heavily dependent upon the timing and nature of the revitalization of community services:

- if a rural community is largely left to its own devices, the establishment of a broadband system is likely to await its 'evolution' to a condition of economic growth.
- alternatively, if substantial outmigration can occur _before_ community services deteriorate to the point of no return, and if a community's resources and population remain in some sort of balance, then it is possible to visualize the feasibility -- without substantial outside assistance -- of a broadband system. Such 'equilibrium' rural communities (roughly equivalent to the Turnaround Reversal category discussed earlier) exist today in the Great Plains region.

The other alternative is direct subsidies and other assistance to upgrade community facilities, in which case it is difficult to visualize any realistic source of funds other than that of federal and state government. In this instance, the feasibility and value of broadband systems is likely to be further dependent upon the extent to which they mesh with and contribute to the objectives of the government assistance programs.

For purposes of discussion -- and to lend some specificity to the "iffy" role of broadband systems in contributing to rural development programs in declining counties-- the example was considered of the so-called "64 mile radius" regional centers that presently are evolving in this country, and that have been offered by one scholar as focal points for organizing government assistance. Briefly, these centers were found to be the location of major trading enterprises, junior colleges, medical facilities, and television broadcasting for the surrounding areas. Of further interest, growth centers of this size have apparently represented viable markets for broadband communications: in 1968, 243 of the 352 64-mile radius centers studies were found to be served by cable television.

Unless overall development efforts have some coherent and realistic purpose, it does not seem that a broadband communications system will make little difference to a declining rural area, even if entirely subsidized from outside sources. As every rural hamlet cannot be the site of a general hospital and a 4-year college -- which implies the necessity for devising some sort of regional system for the delivery of such services -- so, too, is it unlikely that each crossroads can be the center of its own broadband system. To the degree that a larger rural area (the 64-mile radius area is only one example) serves as a basis for coordinating the delivery of medical, educational, or other community services to a region's inhabitants, broadband communications potentially could serve as a substitute for extensive individual travel in realizing the benefit of these services and helping to make the most of available resources.

Summary Observations

- Any area-coverage rural broadband system will require the fullest development of every possible service (entertainment, public, as well as commercial) as sources of revenue. Leaving aside entertainment service as a common denominator in all systems, the principal additional sources of revenue will vary according to the type of rural area:

1) in the fastest growing rural counties (those dominated by growth in the service sector of the economy), business and commercial broadband services are likely to offer the greatest potential source for revenue.

2) in growing rural counties characterized by growth in manufacturing employment, public service uses are likely to represent the best additional source for revenue.

- Broadband systems in growing rural counties could:

1) enable greater dispersal of service-type industries than is presently the case in some of the fastest growing counties. This could permit more equal sharing in the fruits of growth by all sections of a county and make more likely the continued viability of smaller rural communities.

2) help forestall continuing erosion of business functions in those small towns located in areas of manufacturing growth, and provide the communications network necessary for later growth in the service sector, should economic conditions permit.

- Broadband systems in declining rural counties could:
  1) contribute to the cost-effective functioning of federal and state programs designed to upgrade medical, educational and other community services.
  2) help to attract new industries by serving as a vehicle for delivery of upgraded community services.
- Implications for government policy are:[1]
  1) in growing rural counties, broadband systems have the potential for becoming self-supporting; assistance required is likely to be in the areas of technical assistance and securing of financing.
  2) in declining rural counties, the economic base is likely to be inadequate to support broadband systems. However, to the extent that government subsidies might be made available to upgrade schools and other community facilities, some functions might be performed through the use of broadband and appropriate reimbursement made to the system. The latter revenues, venues, in turn, might be sufficient to make the system financially self-sustaining. The value of broadband systems

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[1] Because most statistical data is available on a county basis, the single rural county has been used as the unit of analysis in this discussion. This is not meant to imply that the individual county must be used as a planning basis for government policies affecting the establishment of rural broadband systems. Indeed, in their full-service uses contemplated in this study, rural broadband systems are more likely to be coterminous with the boundaries of school districts and the like, which increasingly are multi-county or sub-regional in nature. For further discussion on this point, see Chapter IV.

in providing public services is likely to depend upon the extent to which these services mesh with and contribute to these government assistance programs, as well as upon the degree to which rural development policy emphasizes area-wide, coordinated delivery of community services.

- Despite the evident promise of broadband communications systems, there can be no assurance that they will in fact evolve in the manner suggested in this Chapter. Before entrepreneurs, local business leaders, or governmental officials can seriously entertain organizing and deploying such systems, much more has to be known about the practical aspects of their financing and operation. This will be the subject of the next and final chapter.

CHAPTER III

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CHAPTER IV

A SYSTEM APPROACH TO DEVELOPING AND ASSESSING RURAL BROADBAND COMMUNICATIONS

The preceding chapters have examined the potential of broadband communications for responding to rural needs and contributing to the goals of rural development. However, realization of this potential depends upon demonstration that rural applications are economically viable. In this Chapter, a system approach to developing economically viable systems is described and two case studies illustrating some of the concepts involved in approach are presented. Technological, regulatory and economic factors as possible constraints to wider application of broadband communications are then examined and it is shown that, for rural areas, the immediate primary constraint has been economic. This finding is used in discussing the need for rural demonstrations of broadband systems and an approach to implementation of such a demonstration program is described. The approach taken in this Chapter is then compared to other alternatives as suggested in recent legislative initiatives and other studies. From that follows a discussion of policy alternatives. The Chapter closes with a three-step approach to future assistance which might be provided by the Office of Technology Assessment for consideration by the Senate Committee on Agriculture and Forestry.

What is Meant By A System Approach

As used here, a broadband communications system indicates specific characteristics. With regard to service, the term "system" implies that all persons in the community served by the system can hook up to it and that community institutions will also have access to the system. Thus, the system will provide an array of services. In addition to conventional news and entertainment such services would include several public services and/or commercial uses as described in Chapter II. By comparison, prior applications (see Chapter II) have provided one service -- say, a health service -- to one type of organization (such as hospitals and clinics) or to a subpopulation of individuals (the sick or elderly). In the context of the system concept, such an application would be a component or subsystem. Several such subsystems combine to form a total broadband system.

Still on the topic of service, there is an important implication of the system concept. This is that the system derives from and is based upon community needs rather than the interests of a single business or group of experimenters. The particular services to be provided may be health, education, entertainment, meter reading, burglar and fire alarms, commodity prices or others, depending upon the needs of the people and the capability of the community to provide these services in other ways.

The system approach implies a positive cost-benefit ratio and that other alternatives than broadband have been evaluated to determine whether the same service might be provided through some other method at lower cost. Thus, it might be cheaper to bus people to hospitals or hire more paramedics than to use telemedicine. In making such an analysis, however, the total service to be provided by the telecommunications system must also be considered. Provision of several services will reduce the cost of any single service because all will use the same physical plant.

Thus, an important reason for the system approach to rural telecommunications is economic. Besides the economies of scale achieved when a number of services are provided, there is also benefit to the individual. School systems, hospitals and community agencies might afford to pay respectable sums for use of the system because of savings made in reduced salaries, transportation costs and physical plant. This institutional support can be used to offset some of the cost of providing network TV via cable to the individual subscriber.

The system approach has technical implications as well. Combinations of technology, such as both cable and translators, may be required to meet the needs of the community economically. Thus, cable can be provided where there is adequate density and several cable systems might be linked by microwave relays to connect related institutions within a county. Translators can provide service to households in the most rural areas. (Regulatory constraints to this approach will be discussed later). The important point is the intent to provide broadband to everyone rather than siphoning off households in the most dense, and thereby profitable, areas and leaving outlying rural households with no access at all.

Service, economic and technological aspects will be dealt with in more detail later. The purpose here has been to introduce the philosophical concepts underlying the system approach.

Case Studies

The project which most clearly illustrates the system approach is being undertaken in Trempealeau County, Wisconsin. However, some other projects, such as the three National Science Foundation Phase II projects in Spartanburg, North Carolina; Reading, Pennsylvania; and Rockford, Illinois show some characteristics of this approach. The Trempealeau County and Spartanburg projects are described below. Besides illustrating what is meant by a system approach, these projects also indicate some of the regulatory, institutional and financial constraints to broadband applications. The description of both projects follows a common framework:

- demographic and socioeconomic characteristics of the area served by the broadband system;
- motivating forces behind the project;
- system description;
- financial considerations; Federal involvement;
- status of the system; and
- summary and significant findings.

Trempealeau County, Wisconsin Project

Trempealeau County, Wisconsin is a predominantly rural area with a population of 23,172 persons. Those younger than 20 years of age, or over 65, make up about 39 percent of the population and this percentage is close to the Wisconsin average. However, the over 65 age group is about 16 percent of the county population, which exceeds the statewide averages by about 5 percent (1-5).[1]

Examination of migration patterns reveals greatly decreased migration out of the county from 1960 to 1970, as compared to the previous decade. While county population as a whole appears close to stabilization, there has

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* References are numbered consecutively in the order of their first appearance in the text. The first number is the reference. The number after the dash is the page number on that reference.

been within county movement from rural farm to rural non-farm households. The percentage of the population in incorporated areas in 1970 accounted for 47 percent of the population compared to 33 percent in 1940 and 21 percent in 1900 (1-6). Persons classified as rural non-farm in 1970 accounted for about 64 percent of the population, with rural farm making up the difference (1-83).

County median income was $7,391. A large percentage of people depend upon public assistance (13 percent of families) or social security (29 percent). In 1970, 14 percent of families in Trempealeau County had incomes below the poverty level (1-7).

Of the total population, 8,233 or 36 percent were in the labor force. Agriculture and manufacturing predominate as sources of employment. Agriculture employs 26 percent of the work force and manufacturing employs 22 percent (1-7).

There are several important implications to be drawn from the above capsule summary of Trempealeau County characteristics. First, the relatively high percentages of elderly and nonworking residents means that a significant percentage of the population is home during the day and could use broadband services during this time (1-9). Presently, 93 percent of households have television sets (1-9). Television usage figures in hours per day are high compared to the national average despite good reception on only two channels in most areas (1-13). Surveys indicate an interest in more choice of programs as well as in local programming (1-14). Besides entertainment, the characteristics of the area suggest a potential for health, education and other services described in Chapter II of this report.

On the other hand, income for many residents is low. Consequently, little is available for discretionary spending. Thus, any broadband telecommunications services based on subscriber fees or fees otherwise charged to the consumer must be very desirable if they are to be purchased. In addition, the low density of the area makes it unattractive to broadband entrepreneurs. A cable system serving the county, including all towns, would have less than 10 subscribers per mile of line (2-15). Cable operators generally consider 30-40 households/mile a minimum (3-4).

Thus, while it appears that broadband communications could fill a need in Trempealeau County, it also appears unlikely that a conventional system will fill that need. Given the situation, the project underway in Trempealeau is of special interest.

Trempealeau County proposes to provide itself with broadband communications by paralleling the approach which brought electricity and telephone service to rural areas. There are many unique features of this project and they are indicated in the following discussion.

Role of Trempealeau County cooperatives. The motivating force behind the Trempealeau County project stems from several cooperatives. Because of the importance of cooperatives in many rural areas and because of their potential for bringing broadband communications to other areas, the following discussion briefly outlines the historical development of cooperatives, their role in bringing electricity and telephone service to rural areas and the current activity of cooperatives in the Trempealeau County project.

The formation of cooperatives stems from the Capper-Volstead Act of 1922 which allowed farmers, ranchers, dairymen and others engaged in agricultural activities to form associations for the purposes of marketing their products (4). The intent of the legislation was to permit agricultural workers to reduce competition among themselves and enable cooperative members to realize the benefits which could accrue from processing, handling and marketing their goods themselves.

Since the 1922 Act, cooperatives have become a way of life in many rural areas and supply an array of services from insurance to schooling for their members. Of notable significance to this assessment is the role played by cooperatives in bringing electricity to the countryside. In the 1930's, realizing that the utility companies saw no economic reason to bring electricity and telephone service to rural America, rural residents organized their own electric cooperatives. Aided by the Rural Electrification Act of 1934 which made long-term, low-interest loans available, the electric cooporatives were extremely successful in bringing telephone and electric service to sparsely populated areas (5-13).

The situation today with regard to cable television in rural areas is not dissimilar from the problem of getting telephone service and electricity to the same areas a generation ago. As noted previously, low rural population densities are not economically attractive to the private cable operator. Cooperatives, on the other hand, exist for the benefit of their membership and are not constrained by considerations of profit as is private industry.

In addition, as noted by Steven Rivkin writing in Rural Electrification Magazine (May 1974, pg. 13):

> "Rural cooperatives have special practical qualifications for entering the field of broadband communications that go far beyond a perception of historical nuances. First there are the vital intangible ingredients to success of motivation -- the commitment born of past struggles to put technology to work for their members -- and the principles of area coverage that makes special sense when success of a high-capacity communications system is so dependent on opening access to all members of community. Moreover, there also may be available physical facilities (i.e., utility poles, whose cost is normally a significant factor in stringing cable), services (such as billing and accounting) and organizational mechanisms (such as an existing cooperative itself)."

In Trempealeau County, cooperatives are numerous and active. Initial interest in the broadband communications project was sparked by Gordon Meistad, Manager of Trempealeau Electric Cooperative, who became interested in the potential of cable for rural areas. He decided that rural residents would have to become actively involved if that potential was to be realized. As stated by Mr. Meistad (Rural Electrification Magazine, May 1974, pg. 16):

> "'I'm not interested in cable to get a few commercial channels. If that's all we were working for I wouldn't waste my time,' Meistad says, 'but we're planning on building a total communications system to serve the future communications needs of every resident of the county. The real goal of the communications co-op is to upgrade the quality of life for our rural members.'"
>
> "Meistad firmly believes that cable communications offers more for rural people than for city dwellers. 'It can, if developed to its full potential, revitalize rural life and keep young people in the area with jobs and every social, cultural and economic advantage. It's going to take hard work and we'll have to do the job ourselves but we did it once with electricity. We should be able to do it again with cable.'"

Others grew enthusiastic about the project. William Urban, Superintendent of Trempealeau Valley School Cooperative, sees two-way cable as a way to improve the quality of primary and secondary education and to save both teacher costs and student time. Interconnection of schools would permit special teachers at individual schools to make their services available to all without the need to bus children between schools. Cable would also permit bringing education to the handicapped, the elderly and any other citizen who wished to increase his education.

The project obtained the support of the Trempealeau County Association of Cooperatives and its president, Gerhard Nilsestuen.

The outcome is the Western Wisconsin Communications Cooperative. WWCC is a consortium of 23 Trempealeau County cooperatives and seven schools (2-14). One school in Jackson County is also involved (6-3).

A county-wide, multi-service broadband communications system. As indicated in the quotes from Mr. Meistad and Mr. Rivkin, the Western Wisconsin Communications Cooperative proposes to provide a broadband communications network accessible to all 9,500 households in the county (2-14). This in itself is unusual and a dramatic departure from the economics governing most private cable operators. Densities of some areas in Trempealeau County are at least as low as 3.5 households/cable mile (2-15), far below commonly accepted figures for a profitable cable operation. Nevertheless, provision of service to all members is a tenet of cooperatives.

The question is how such a system can be economically viable. Indeed, an early feasibility study for Trempealeau Electric Cooperative (1-46) showed that provision of cable service to Trempealeau County residents would be marginal at best. What substantially altered the outlook was the active involvement of local institutions in the use and support of the system, a development which reflected the principle of the system approach earlier described.

The key institution to be involved in the early phase of the project is the schools. Linking of Trempealeau County schools will form the backbone of the initial system. The higher fees charged the schools will reflect institutional (as compared to individual) use and the contemplated savings to be achieved by the county as a whole in education. The institutional rates will permit lower individual subscriber costs than would be possible if individuals alone were supporting the system.

System description. The proposed system will combine cable and microwave technology (6-1; 7-1). The system will be installed in three phases at an estimated total cost of 5.5 to 6 million dollars (8-3).

In Phase I, the schools and homes in the larger communities will be interconnected. Figure I on the following page shows major towns involved in Phase I. The eight schools are located in Arcadia, Blair, Eleva-strum, Galesville, Independence, Osseo and Whitehall in Trempealeau County and in Taylor in Jackson County (6-3). (One Jackson County school is included because cooperative and educational system boundaries are not always congruent with county boundaries.) Three private parochial schools may also be included. The schools and nearby homes will be cabled and there will be three microwave receivers to interconnect the cable systems and pick up channels from distant cities. In the initial phase, 64 miles of transmission cables and 43 miles of distribution wires will be installed. The system will be available to about 2300 private residences and 230 commercial and educational organizations (9-1ff.).

The Phase I system will use 6 channels directly, be immediately expandable to 8 channels and be sufficiently flexible that additional channels can be made operational (7-1). Initially, only the schools will have two-way capability.

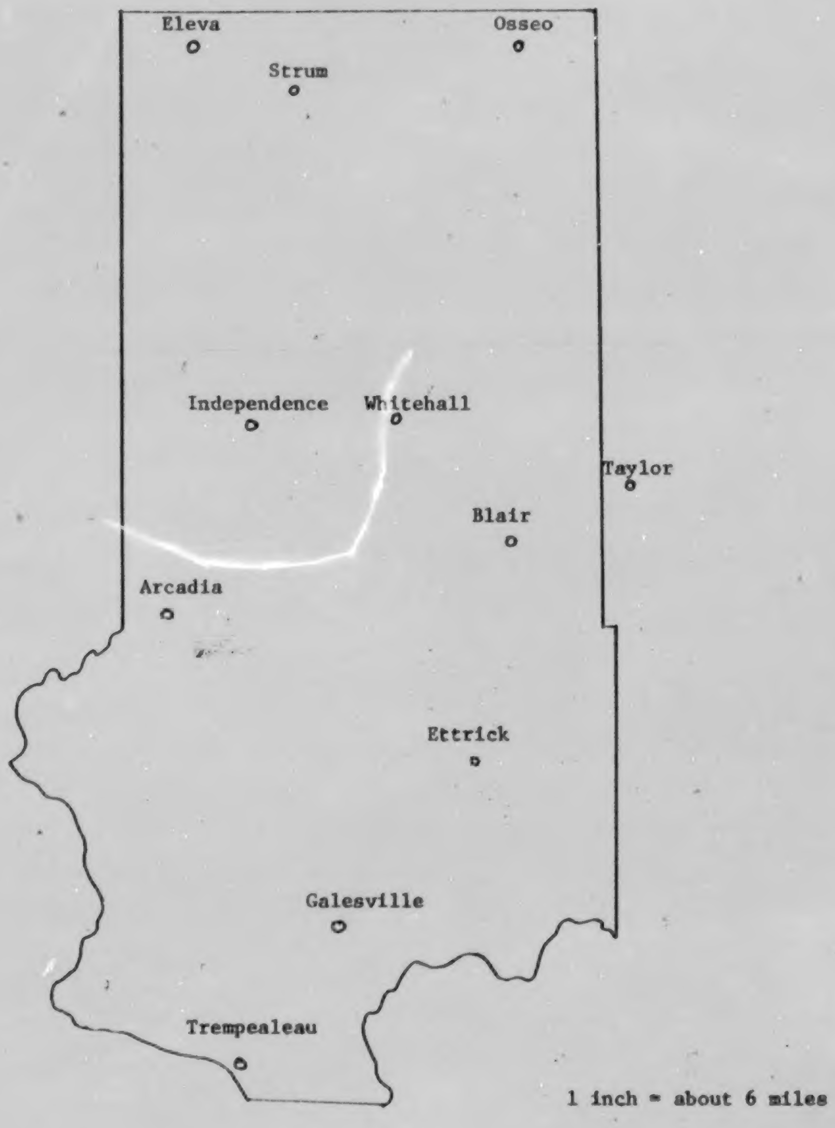
Eleva
Osseo
Strum
Independence
Whitehall
Taylor
Blair
Arcadia
Ettrick
Galesville
Trempealeau
1 inch = about 6 miles

Figure 1. Location of communities in Phase I (based on map in 6-2).

Phases II and III will expand the system to the less densely populated areas so that the facility becomes available to every resident and business. The smaller villages will be connected in Phase II. The most isolated farms will be connected in Phase III.

Initially, the system will provide individual subscribers with network TV and the educational and single independent channel permitted by the FCC. [A waiver will be sought to permit bringing in two independents (10).] Subsequently, however, the possibility of additional services such as fire and burglar alarms, will be explored (10,11). The Cooperative is also eager to provide service to institutional users other than the schools. Preliminary conversations indicate an interest by the banks. At present there are 11 independent banks with 42 branches. There appears to be interest in use of a central computer by the banks and even in the possibility of using the proposed system to eliminate the need for checks (11).

Financial considerations; Federal involvement. The consulting engineering firm of Ralph Evans and Associates retained by the Western Wisconsin Communications Cooperative (WWCC) estimated the Phase I cost of the system at $1,245,000 (7-10). In seeking outside financial assistance, the Cooperative explored the possibility of a Rural Electrification Administration (REA) loan. When receipt of an REA loan appeared unlikely, WWCC applied in January 1974 for a Community Facility loan from the Farmers Home Administration (FmHA) under the Rural Development Act of 1972. In two subsequent letters (12, 13) the FmHA identified approximately 20 conditions which must be met. After WWCC agreed to meet these conditions, the Wisconsin FmHA State Director approved a $1,238,000 loan on August 28, 1974 and obligated funds for it.

This loan is unique in that it is the only Community Facilities loan granted under Title I of the Rural Development Act of 1972 for the purpose of establishing a broadband communications system. FmHA has approved a direct loan with a 15 year repayment period at 5% interest with repayment of principal deferred for 2 years (14). Of the conditions imposed by FmHA, one posed a particular problem and is illustrative of some of the difficulties faced by projects such as this one. FmHA required that long-term contracts between the eight schools and WWCC be established. However, the schools are prohibited from participating in any agreement longer than 3 years without voter approval. Such approval for a 10 year contract has been agreed to by the voters. In addition, a bill pending before the Wisconsin legislature will permit schools to make such contractual arrangements (11).

WWCC is concerned that private operators might skim off the more profitable densely populated areas of the county. The difficulty which WWCC experienced in promoting and financing their own system has stimulated another bill now pending before the Wisconsin State Assembly. This bill would allow intercommunity cable districts to organize and float municipal bond issues to raise funds for intercommunity cable systems (2). Arguments advanced in favor of the bill are that it will protect rural areas from lack of cable service, prevent formation of "pockets" of sparsely populated areas lacking broadband services and promote cable system compatibility (10). The bill has been defeated once but is expected to come up again.

In the Trempealeau County system, financial support and loan repayment will come from installation fees, membership fees and user charges. A small amount of revenue from advertising is also anticipated. Individual subscribers will be charged a $20 installation fee, $5 for membership in the cooperative and about $7/month for access to the system. The eight school districts will each pay a $1,000 installation fee and $9,000/year for two-way use of the system (9-1ff.).

Although the user charge to the schools may seem high, the potential savings of the school system may be even higher. The broadband system will permit the connected schools to share teachers. Students in special programs will no longer have to be bused between schools. In-service teacher training can also be done on the cable system.

Later the banks are likely candidates for use of the system. A channel could be bought by several banks and used for in-service training, computer access, etc. $7,000 has been cited as a reasonable figure for rental of a channel per bank for one year (11).

Status of the system. As previously indicated, the Community Facilities loan from FmHA was approved August 28, 1974. However, construction of the system has not yet begun because of the need for a long term contract commitment between the schools and WWCC. Although voter approval of this commitment was obtained, state level action was also necessary. Thus, progress has been delayed pending action by the Wisconsin State Assembly on a bill approving entry into long term contracts by the schools. The bill will probably come to a vote early in calendar year 1976 (15).

In addition, FmHA imposed a condition that WWCC obtain signed membership pledges from 1008 households as evidence that the system will be used and bring in revenue in its first year (13). Early indications of subscriber interest suggest little difficulty in meeting this requirement.

The engineering consulting firm of Ralph Evans and Associates has prepared the specifications for bid for a turnkey contract. The specifications will be released as soon as there is state level approval for the school system contracts.

If the Wisconsin State Assembly acts favorably early in 1976, Phase I construction can possibly be completed by late fall. If the Assembly does not act until later in the year, a problem arises because of the increased costs of installing the system under the climatic conditions which prevail in Wisconsin during the winter. Possibly, Phase I will be delayed until 1977. If the Assembly disapproves the bill, the entire situation must be re-examined.

Once implementation of Phase I is begun, about four years will be required before the detailed benefits of the Phase I system to the schools can be known. The first year will be devoted to construction and interconnection of the schools. During the first and second years, the schools will be developing their approach to using the system. The third year will be experimental and in the fourth year, the school system should be fully operational. These plans are reflected in the projected school user charges. The schools will not be charged for system use until the third year and then at a 50 percent rate (i.e., $4500 per year). Full charges will go into effect in the fourth year (14).

During the four year period described above, other activities can proceed in parallel. Thus, Phase II implementation, provision of additional services to individual subscribers beyond network and ETV, and involvement of other institutions such as the banks can be initiated. It is important to note that long time periods will be required to install, develop, and evaluate the innovative broadband uses such as contemplated in Trempealeau County. Thus, data on the value of systems such as the one proposed for Trempealeau County will not be available for a considerable number of years, even if work begins now.

Summary and significant findings from the Trempealeau County case study. The following summary discussion of the Trempealeau County project highlights the most significant points of this case study as they bear upon the future of rural broadband systems generally.

- the primary motivational force for the Trempealeau County project lies in the cooperatives, -- nonprofit organizations oriented to benefits for all members;

- within Trempealeau County cooperatives, a few key individuals have played significant roles in attempting to make an idea a reality;

- the underlying philosophy of the cooperative movement in rural areas led naturally to the concept of an areawide service which would serve all members even if their geographic location rated them poorly in the equation of cable system economics. This philosophic viewpoint was augmented by the vision of a few key persons concerning the full potential of cable in rural areas. At the same time, these key persons foresaw the consequences of granting cable franchises for the most densely populated and profitable areas alone. Such franchises would mean that the most isolated residents would be left out of the cable system;

- feasibility study showed that provision of standard cable service in terms of improved network TV and ETV would not be economically viable -- a not surprising result given the low population density of Trempealeau County;
- the key motivating persons foresaw more than a standard cable system. Involvement of an institution, the schools, had many advantages. It was hypothesized that educational costs could be reduced while the quality of education was increased. Another significant benefit was lower individual subscriber fees than would be possible without institutional involvement. These economic benefits could be augmented by potentially higher quality education for all residents of the county;
- a Community Facilities loan under Title I of the Rural Development Act of 1972 was obtained. This is a unique loan-- the only one granted under Title I for a broadband system. Trempealeau County was fortunate in the timing of its application, which occurred shortly after Title I funds became available. Recently set priorities for the granting of such loans (16) plus the increasing competition for them indicates that this source of funding for broadband systems is unlikely to be available in the future. Indeed, correspondence to OTA from the FmHA Administrator states that "we do not anticipate this type

of loan (i.e., for broadband systems) becoming a significant part of our community facilities loan program" (17);

- although FmHA provided assistance to Trempealeau County in the form of a loan, FmHA assistance did not extend to helping develop the rationale or justification for the system, nor did FmHA act as coordinator with other appropriate Federal agencies, such as the FCC. Trempealeau authorities were, and are, on their own in devising, and organizing their system. If the latter had not been possessed of a high degree of initiative and perseverance, it is not likely that they would have progressed as far as they have;
- Trempealeau authorities do not have a clear idea of concrete plans for service to be provided beyond community access to network and educational TV programs and use of the system by school districts. Some assistance, Federal or otherwise, probably will be necessary if the community is to realize such potential benefits as using the system for commodity and cattle market information; hospital and medical services; and fire and burglar detection. Revenue from these additional services might be essential to the economic viability of the expanded system now contemplated by local authorities;
- in Trempealeau, and elsewhere, state laws can constitute a major barrier to the development of community-based rural systems. The lack of authority for Trempealeau County school districts to enter into long term contracts has delayed implementation of the system;

- the tendency of cable entrepreneurs to buy up cable franchises in the most densely populated areas can isolate less densely populated areas from receiving service because the most economically attractive areas have been removed from the system;

- the desire to build an area-wide system is frustrated by the fact that townships cannot grant cable franchises. Thus, those interested in implementing an area-wide system are forced into the position of acquiring franchises from municipalities with hopes that intervening townships will join the system but with no guarantee that they will do so.

To summarize, the Trempealeau County project is a unique effort. It is an attempt to provide broadband telecommunications services by following the tradition of providing electricity and telephone service to rural areas through the use of cooperatives. The success or failure of the project will have significant implications for similar endeavors by other rural communities. It should be noted that other projects of this type are not likely to come to fruition under current conditions because of constraints on funds and the lack of a Federal program supporting demonstrations with objectives similar to those guiding the Trempealeau project.

Spartanburg, South Carolina Project

Unlike Trempealeau County, the Spartanburg, South Carolina project is taking place in a small city and contiguous parts of Spartanburg County rather than in a rural area. However, there are two reasons for including Spartanburg as one of the two case studies of this Chapter. First, the Trempealeau County project was initiated by cooperatives. For comparison, it is useful to examine an example in which the Federal government has taken the initiative with the involvement of a consultant and private industry. Second, while Spartanburg is not rural, the services being investigated are applicable to rural areas. Aspects of the detailed cost analyses which are part of the Spartanburg project, such as transportation and telecommunications tradeoffs, will be suggestive of the results that might be obtained in rural areas.

The city of Spartanburg had a 1970 population of 44,546 persons. It has its own radio and television stations, newspaper, Spartanburg Technical College and other institutions. The black Community accounts for 33 percent of Spartanburg's population (18-II-1).

The table on the following page illustrates the demographic characteristics of the city and county of Spartanburg compared to South Carolina, the South Atlantic States and the U.S. as a whole. Of particular note in the table are the reduced educational and income levels in Spartanburg compared to the U.S. as a whole. There is also a larger proportion of families below the low-income line defined by the Bureau of the Census. Per capita expenditures for local government services are about half those for the U.S. average and are lower in the city than in the county. The reduced staff and budget in the city reflect the responsibility of the county for many public services, including education and health for both city and county residents (18-11-3). The lack of responsibility of the city for social services may be contrasted with the fact that only the city can grant cable franchises (19).

- National Science Foundation (NSF) - this agency is funding the project as part of a comprehensive telecommunications research program;
- The Rand Corporation - Rand is the contractor for the experimental studies in Spartanburg;
- TeleCable Corporation of Norfolk, Virginia - TeleCable is the owner/operator of the Spartanburg system, one of fifteen cable systems owned by TeleCable;
- Jerrold Corporation - Jerrold installed the cable system under a turnkey contract;
- state and local organizations - these are involved in the services the system provides.

Each of the above groups is motivated to participate in the project for different reasons. Thus, the state and local organizations are interested in the services which the system can provide while the Jerrold Corporation has used Spartanburg as a test-bed for its second generation of two-way equipment, especially its unified amplifiers (19).

One of the factors leading to the initiation of this project involving NSF, Rand and Telecable was the reassessment by the Federal Communications Commission (FCC) of its position on two-way cable systems. In 1972 the FCC ruled that all cable systems in the 100 largest markets must have two-way capability by March 1977. However, such factors as less-than-expected profitability of cable systems and inadequate evidence on the actual value of return signals has led to postponement of the rule. Three National Science

Foundation projects, of which Spartanburg is one, are expected to provide data to the FCC and others on the value of two-way cable systems (18-I-1; 21-1).

As a cable operator, TeleCable is interested in the revenue potential of new services via two-way cable as well as the final outcome of the FCC decision. TeleCable worked extensively with Rand in developing Rand's proposal to NSF. As stated by Mr. Rex Bradley, President of TeleCable corporation in a letter to Dr. Leland Johnson of the Rand Corporation (18-VII-18): "We feel the social service delivery projects selected by Dr. William Lucas and his staff are meaningful experiments which will serve well in determining the future usefulness of broadband communications over cable television facilities for the delivery of social services." It might be noted that this is not the first time TeleCable has been involved in social services. For example, at their Overland Park, Kansas installation, cable was used for in-home education of two severely handicapped teenagers (21-2).

System description. The Spartanburg cable system is a high quality state-of-the-art two-way system which has been relatively free of many of the technical problems encountered by other systems. It provides twenty-seven forward or "downstream" and four return or "upstream" video channels. Twelve of the forward channels are used for major broadcast stations, locally originated programs and automated programming, leaving fifteen downstream channels available for other purposes. Three of the return channels are available for experimental use (21-2ff.).

The system provides extensive coverage. As of late 1974, of 10,000 city dwellings, 8000 were within access of the cable, as were 6000 in the county. Of the total with access, half, or 7000, had subscribed (21-2). Plans for expansion will provide access to an additional 6000 homes in the city and county (18-II-8).

Description of experiments. Actual needs of the area which might be supplied by cable were established through meetings held with more than 60 agency departments and offices at local, district and state levels (18-II-6). Persons interviewed were encouraged to define their problems and then consider how telecommunications might help, rather than being presented with the technology and asked to suggest ways to use it. There is some suggestion that these two contrasting approaches produce different results (21-3) and that where the technology is sufficiently flexible, as in Spartanburg, more meaningful needs assessments can be obtained by concentrating on needs rather than technology (19). Six months were spent in a careful needs analysis (21-3). Three basic groups of experiments were identified in the areas of:

- adult education;
- training of day care workers; and
- communications between social service agencies.

The education experiment attacks one of the major social service needs in Spartanburg and South Carolina. South Carolina is 49th in the United States in median years of education (10.5 years), and 62% of its adults have not finished high school (18-III-2). According to the Rand proposal "in the areas accessible to the Spartanburg cable system alone, there are approximately 20,000 adults without a high school education; 10,000 of these Spartanburg residents don't have an eighth grade education" (18-III-2).

Despite past efforts to upgrade the educational level of area residents by Spartanburg public schools and Spartanburg Technical College, much remains to be done. Current programs reach only a small proportion of those who could profit from them: in South Carolina, such programs have enrolled 1% of adults lacking basic (less than high school) education and about 2% of those lacking a high school education (18-III-3). Of those enrolled, only a small proportion complete the programs (18-III-3). Significant reasons for dropout are difficulty arranging transportation and difficulty meeting child care needs and related family responsibilities (18-III-3). These difficulties are equally or more applicable to residents of rural areas, indicating the applicability of Spartanburg project to rural as well as more urbanized areas.

Broadband communications, by bringing education to those needing it, rather than requiring them to go to the source of education, might circumvent the barriers cited (see Chapter II for further discussion rural needs in education). What remains to be demonstrated in the Spartanburg experiment is that quality education can be achieved through the use of broadband communications.

The purpose of the project will assess telecommunications as a method for providing second level basic adult education (grades 6-8) and high school equivalency education (18-III-1). The following three techniques will be tested: traditional classroom; one-way television; and two-way television using pushbuttons alone or pushbuttons with return voice for student response (18-I-2; 19-4ff.).

Measures of effectiveness of the three methods are directed at asessing both benefit and cost. Tests of educational progress such as the TABE (Test of Adult Basic Education) and GED (General Educational Development) will be used to measure student learning (18-III-17ff.). In addition, updated measures of student progress will be available throughout the telecommunications experiments (19). With regard to cost, careful records of the cost to maintain, operate, and administer the broadband system will be kept in these and other experiments (19). Specific costs associated with the educational program which will be measured include direct instructional costs and student travel costs (18-III-18). Perhaps the hardest to obtain -- yet the most significant -- measure of the benefit of this program is its value to students who are reached by this system who wouldn't be reached otherwise (18-III-18). The latter are those students who couldn't partake of the benefits of adult edcuation if obtaining it requires going to a classroom. While student questionnaires will enable an estimate to be made of the proportion of these students and their response to the program (18-III-18), it is unfortunate that a better means of determining this value is not available.

The second experimental application in the Spartanburg project is use of broadband telecommunications to train day care personnel. As stated by William Lucas of the Rand Corporation (21-6):

> "The need for quality day care has grown substantially in recent years as the number of women in the work force has grown. Child care in centers has grown more sophisticated as more positions are filled by well-trained personnel, but in-home and family care is a continuing problem. In these situations, the child either remains at home or is kept in the home of the caregiver, typically a neighbor or relative who is often a mother with children of her own. All too often this caregiver sees herself as little more than a babysitter. Even if she would like training, it is difficult to acquire because she is tied to her home. In the day, she must usually care for several children by herself, in the evenings and on weekends she must tend her own family. Of course, some caregivers are so motivated they attend occasional training workshops despite the inconvenience, but for the general population of this type of caregiver, effective training needs to reach into the home."

Despite recognition of the need for training of day care personnel (19-IV-8), the above quotation indicates the reasons such training is difficult to implement. Some of these reasons are identical to those which make adult education difficult to provide -- the necessity to go to a training center, which is prevented by conflicting demands on the trainees time. As in adult education, broadband is a potential way to resolve such problems in both rural and urban areas.

The day care training experiment uses a workshop approach with training workshops conducted in the cable studio and in homes and day care facilities in the field. According to the project prospectus, "participants in homes and centers will be seen as they ask questions, show techniques and exchange experiences with the professional leading the workshop. The multipoint distribution capacity of the system will be used to send the workshop and the associated dialogues [between the professional leading the workshop who may be located at the cable studio or one of the home or day care facility sites and day care workers at other locations] live over a closed channel to members of the day care community throughout the system" (18-IV-1).

Day care training by three different methods will be compared. For one group, five television cameras will be rotated among the studio and homes or facilities so each has a chance to actively participate. By switching the cameras on and off at the various locations, caregivers at sites with cameras can see and hear each other. A second group of caregivers will be able to watch the program but these people will not be able to actively participate because they will have no return equipment and thus cannot be heard or seen. A third group will receive the materials used in the workshop but will not have access to the cable system.

Videotapes of the workshop sessions will be saved, permitting changes in caregiver skills to be later identified and analyzed (19).

Cost-benefit analysis comparing one and two-way cable with actual visits to the home or facility to provide training sessions also will be conducted. Elements of this analysis will include cost of developing the materials, travel to homes, the wages and salaries of visiting training personnel, costs associated with use of the cable system, and the number of caregivers reached (18-IV-36ff.).

The third set of experiments in the Spartanburg project involves use of cable to facilitate inter-agency communications. One such application is reduction of the time and costs associated with the processing of applicants for federal assistance programs which require processing by more than one local agency. The specific program which is the subject of this experiment is the Work Incentive or "WIN" program which is administered by the U.S. Department of Labor and Health, Education and Welfare (18-V-7). Screening and approval for this program involves two agencies and several client visits. The associated problems of setting appointments, arranging and paying for client travel, and inter-agency interactions means that approval of the application requires considerable time -- an average of 77 days in Spartanburg on the basis of a small sample (21-9). In this experiment, cable will permit interviewing of the client and processing of papers by both agencies with the client remaining in one location (21-9).

Elements to be evaluated include the time necessary to complete the application process, with and without the cable system, and associated costs (which will take account of the travel costs for the client, work time lost, and child care costs) (18-IV-4). Another measure is the reduction in the backlog of cases which the cable system may permit (18-V-16).

Financial considerations; Federal involvement. The commitment of the National Science Foundation to the three experiments in this project totals $1,106,566, over a three-year period. The dollar value of TeleCable's and Spartanburg Technical College's contribution in terms of system or personnel costs is not known.

Previous sections have described some of the specific analyses of costs and benefits which will be undertaken in connection with the three sets of experiments in adult education, day care training and interagency communications. In a more general view, there are basically three types of costs on which data are needed in order to establish the potential for cable communications in providing social services. These are (19):

- the additional cost of two-way cable;
- the cost of the services themselves using the cable system; and
- transportation/telecommunications cost trade-offs.

The proposal for this study submitted to NSF by the Rand Corporation confined itself to providing data on the second of these categories of cost. This is not surprising, given the difficulty of quantifying the marginal costs of two-way cable and the tradeoffs between costs of transportation and telecommunications. Nevertheless, on their own initiative, project personnel will attempt to provide data on these more difficult costs. Despite the difficulty, other investigators should be encouraged to provide similar data.

The interagency communications experiment will provide data on two of these cost categories: services costs and the tradeoffs between transportation and telecommunications. The day care experiment will be used to estimate the marginal cost of two-way cable. The education experiment is difficult to evaluate in terms of any of the above three categories of costs because the bulk of the population served will be those who wouldn't have been reached otherwise.

Another important consideration is the potential economic viability of the system after NSF support is discontinued. NSF has indicated that economic viability and consideration of ways to continue the services beyond the period of NSF support was one of the criteria in the selection of contractors for this study (22). In addition, interviews with key project personnel (19, 20, 23, 24) suggest that the long-term viability of the system for providing public services is of considerable personal concern. Funding for related projects is being sought, notably from HEW. Hopefully, the experiments will also demonstrate the value of the services provided -- and the cost savings achievable -- to state and local authorities. Local support of the system on the basis of demonstrated cost-benefit might then be negotiated. Such an outcome, involving as it would, the provision of these innovative services on a self-sustaining basis in a privately owned system, would be both significant and important as a precedent within the industry.

Status of the system. The Spartanburg project started in September 1975 and is scheduled for completion in December 31, 1977. The adult education and day care experiments are well underway. Substantive reports on various parts of the project will be prepared as data are available. For example, a report on the social benefits of broadband telecommunications for the training of day care operators should be ready in the fall of 1976. Significant data on transportation/telecommunications tradeoffs derived from the interagency experiments should be available in early 1977.

Summary and significant findings from the Spartanburg Case Study. This section draws together some of the points already made and summarizes additional ones to highlight the relevance of the Spartanburg project to the potential for broadband communications systems in rural areas.

- While Spartanburg is not a rural area, the project has the potential for demonstrating the cost-effectiveness of cable for providing a combination of several public service uses. If so, the data may suggest that such services could be economically feasible in rural areas as well;

- Despite the involvement of a private cable operator in Spartanburg, many problems block the entry of the private entrepreneur into similar enterprises. The difficulty of interacting with a multitude of state, regional and local agencies to put together the necessary combination of public service uses, each of which, taken by itself, might not warrant the costs involved in installing a two-way system is significant. There is a need to demonstrate that a potential market exists. The Spartanburg project is a step in that direction. In addition, the possibility of encouraging the development of a new kind of entrepreneur who is a "broker" for combining telecommunications services should be considered;

- an important prelude to putting together a successful combination of public services is a careful analysis of community needs and the matching of those needs with the capabilities and costs of cable;

- the Spartanburg project so far has generated a list of some 40 additional applications which could be served by the broadband system;

- better methods for quantifying benefits are needed. An example is determining the benefits of making adult education available to those who won't or can't come to a specific classroom but who can partake of such opportunity "on the cable";

- unionization (or lack of it) has a significant effect on system costs. In Spartanburg, studio costs are about $25/hour for most programs and only one operator is required. In unionized New York City, the same program would require 3-5 people at much greater cost;

- as in Trempealeau County, success of the Spartanburg project depends on the personal commitment and vision of a few personnel, among whom are the Rand Corporation Project Leader and Site Manager, the Dean of Continuing Education at Spartanburg Technical College and Telecable employees.

Constraints To Wider Application Of Broadband Communications In Rural Areas

In preceding sections of this Chapter, the system approach was defined, and the Trempealeau County project, which most clearly illustrates the system approach in a rural setting, was described. The experiments supported by the National Science Foundation in Spartanburg, South Carolina, were discussed to illustrate other uses of broadband communications to meet public service needs. The latter experiments will also provide needed data on transportation/telecommunications tradeoffs and the costs and benefits of providing public services by broadband or alternate methods.

The following discussion addresses factors which constrain more widespread use of broadband communications to meet rural needs. This discussion begins by identifying those technologies which were included in the study as having potential for meeting rural needs beyond supplying news and entertainment. The degree to which technology is a constraint is then considered. Thereafter, regulations and economics as they apply to the technologies and act as constraints to wider use of broadband communications in rural areas are discussed.

Technology

As requested by Senator Talmadge of the Committee on Agriculture and Forestry, this study was concerned with the potential application of broadband communications to rural areas. "Broadband" communications refers to transmission of many television voice and/or data signals through a single system. The transmission may be through the atmosphere or through wires or fibers. There is no clear point of separation between broadband and narrowband.

For the purposes of this study, the term "broadband" indicates a communications system employing one or more of the following technologies:

- coaxial cable
- fiber optics

"hardwired" - a solid substance (wires or glass fibers is used for transmission

- translators
- microwave
- satellite

transmissions are broadcast -- a solid medium is not used

In general, broadband as used in this report implies two-way interaction with video as well as voice and/or data in at least one direction. It will be noted that of the above listed technologies, coaxial cable and fiber optics can accommodate transmissions to and from individual users whereas translators, microwave and satellite are generally used to transmit signals in one direction only; namely, to the user. Because of the potential value of low-cost translators in rural areas, an additional technology, the telephone, was included because it can be employed to provide return audio signals as a response to audiovisual signals sent to users by means of the translator.

It is important to note the technologies excluded from this preliminary assessment. Conventional telephone service except as previously noted was not included.[1] Broadcast over the airwaves from a single station, whether audiovisual or audio only, was not included. Thus, network or independent television stations broadcasting on a single frequency, and radio stations, whether fixed or mobile, commercial, military or citizen's band,[1] were not included. However, some consideration has been given (later in this Chapter) to the implications for the telephone and broadcast television industries of increased usage of broadband telecommunications.

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[1] It should be noted that there are many potential uses for conventional two-way telephone to provide public services in rural areas. However, the requesting committee expressed its interest in broadband communications, and for this reason conventional telephone was not given major attention in this preliminary study. Applications solely based on conventional two-way telephone were considered outside the scope of this preliminary study.

A more detailed description of the technologies is presented in Appendix D. Technical characteristics of the technologies and costs asssociated with their use are included as well.

For purposes here, of this discussion, it is sufficient to note that there are a variety of technologies available which can be combined in various ways to meet rural needs. For example, cable can be used where it is economically feasible. Where density is very low there are two options. The uneconomic areas can be subsidized by the denser areas. This is the essence of the cooperative approach which is dedicated to providing full service to all members. Alternately, low cost translators can be used to provide service to less dense areas with response capability provided by telephone. However, the latter service will be inferior to cable because video return by telephone is not within the state-of-the-art and response is thus limited to voice or pushbuttons. Microwave or satellite can be used to link several rural systems with distribution to individual users accomplished by cable or translator. (It will be recalled that the Trempealeau County system will use a combination of microwave and cable.) Fiber optics is a new technology which, while still experimental, is developing rapidly. Its value lies in its potential lower cost than cable, as well as its vastly increased channel capacity. A fiber optic cable of the same diameter as a coaxial cable could carry one million times more information.

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[1] Citizen's band radio has been in extensive use in rural areas for a number of years and its obvious advantages of flexibility and low cost could continue to make it a valuable supplement even after a broadband system was established.

In general, it can be said that technology is not presently a limiting factor in bringing broadband communications to rural areas. In the future, if several two-way public services cannot be time-shared and must be transmitted simultaneously, along with a number of conventional television channels, then channel capacity of conventional cable would become limiting. Meanwhile, existing technology is adequate to test the feasibility and value of public service and/or commerical use of broadband communications in rural areas. If success in initial demonstrations generates demand beyond present day technology, then fiber optics at that time may well be available to meet additional demands for channel capacity.

Since technology is not limiting, reasons for the failure of broadband communications to penetrate farther into rural areas must be sought elsewhere -- in regulatory or economic constraints. These are explored further below.

Regulation

The following treatment of major regulatory issues affecting the future of rural broadband systems treats the two main technologies for local distribution of broadband service to rural areas: cable and translators. In addition, because of recent strides in the development of fiber optics, some indication will be given of the consequences for rural systems of the alternative ways in which future regulatory decisions concerning fiber optics may be handled.

In discussing these three technologies, first the regulatory constraints will be outlined and then their implications for rural systems described. At the end of the section will be a brief overview of the principal issues.

Cable. Cable regulations vary with the location of the cable service in relation to the top 100 television markets in the nation.[1] However, because some rural areas fall within television range of stations in these markets, the full range of FCC regulations -- those concerning the "top 100" as well as those pertaining to remote rural areas -- must be considered.

At the present time, FCC rules, based upon the Cable Television Report and Order of 1972, provide that cable systems in the top 100 markets may import a limited number of distant signals (usually two or three) and must provide:

- transmission of local broadcast stations;
- a channel for local educational programming, free for at least 5 years;
- a channel for use by local government, free for at least 5 years;
- a free channel for use by the public on a first-come, first-served basis;

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[1] Market rank of major television cities is determined from the number of prime time viewers and ranges from the first market (with the largest number of viewers) to the 100th. Those falling outside the top 100 are not ranked.

- at least one channel for local programming if there are more than 3500 subscribers;
- channels which may be leased for other services.

The 1972 FCC rules also required that cable systems in major markets must provide at least 20 channels by 1 March 1977 and that for each channel carrying a broadcast signal, at least one channel must be available for nonbroadcast use (27-16; 28-74; 29-6). Another rule promulgated in 1972, but without a specific date for compliance, was that cable systems must be able to accommodate return signals from the subscriber to the control center. Concerning the latter rule, in addition to the absence of an effective date of implementation, it is significant to note that neither video nor voice return capability are required, although both are well within the state-of-the-art. Instead all that is required is a simple response capability as can be accomplished by pushbutton.[1]

Concerning the above rules, the requirement for existing systems to meet 20-channel capability has been indefinitely postponed because of adverse economic conditions facing the cable industry (27-16). In addition, the requirement that cable systems with more than 3500 subscribers must originate programming was stayed by the FCC during litigation.[2]

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[1] It should also be noted that cable systems existing prior to March 1, 1972 are "grandfathered" and need only continue the service they offered at that date (27-15). Thus, they are exempt from the public access and other dedicated channel requirements of the 1972 rules.

[2] U.S. vs. Midwest Video Corp., 406 U.S. 649 (1972). Although the Supreme Court upheld the rule, the stay was never vacated so the rule is not in effect (32-9).

As indicated, the above rules described pertain to cable operators within the top 100 markets. Outside these areas, the FCC rules on channel access for public, educational and government use do not apply.

There are three important implications of these rules for rural cable applications as discussed in this report:

- First, without encouragement from the FCC to provide return capability on cable systems, it is not surprising that most do not provide such capability.[1] The reasons advanced against two-way are lack of demonstrated need and the uncertain prospects for marketing such a capability for the benefit of the cable operator and/or the community. On the other hand, without an existing technical capability for two-way service, it is impossible to explore its value and its potential for economic viability. The result is a self-perpetuating circular situation.

- Second, the FCC requirement that channels for educational, government and public use be provided free of charge makes sense only where such services cannot be used to generate revenue. Applied in a blanket fashion to all systems, it could bar the development of the rural systems contemplated in this report. As will be recalled from the earlier discussion, the feasibility of area-coverage rural systems will depend upon the revenues to be received from the use of excess channel capacity for public service and commercial uses. Had Trempealeau County, for example, been located within a top 100 market area (and subject to FCC requirement for such markets), it is entirely possible that the project would not have been attempted. Without revenue from the school systems (and citizens might well have objected to paying for channels that were meant to be free of charge), low population density and other unfavorable characteristics would have made the system economically unattractive. In this connection, it should be emphasized that payment for such institutional use of channels should not necessarily represent a net increased burden for the residents involved. As in the case of Trempealeau County, savings from the use of the broadband system may offset the costs. As a further comment on the difference between the concept underlying the FCC "free of charge" rule and that of the full-service rural systems discussed in this report, it should be noted that the FCC concept implies the use of broadband as a supplement to education while the usage contemplated here is an integral element of the basic delivery system for educational services.

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[1] It should be noted that systems for major market areas now being installed by some major multi-system operators do provide for conversions to two-way. Anticipated conversion costs are about $500 per mile (compared to basic installation costs of $4300/mile).

- Third, the current debate over possible relaxation of cable regulations has focused on such issues as the number of distant signals which the cable operator may import (presently three in markets 1-50, two in market 51-100 and one outside the top 100 markets) and on the pro's and con's of restriction of cablecasting of sports events and movies (31-160).

This is a debate between the broadcasters and current cable operators over the areas in which they presently are in conflict: entertainment and sports events. If the potential for full-service rural broadband systems is not considered in this debate, it is possible that the dispute may be resolved solely on merits of the cases as viewed from the urban perspective -- when in fact, those also affected by the outcome will be rural residents.

This is not the only example of the problems that might persist if the interests of rural systems are not taken into account. On the one hand, the FCC does not restrict nonentertainment uses of cable (which could have the effect of permitting the development of the broadband systems discussed in this report). But on the other hand, FCC regulations on the importation of distant signals are most restrictive outside the top 100 markets (27-55), which could have the unintended effect of frustrating the development of the very systems that could provide the nonentertainment services that FCC has decided not to constrain. This is because a full range of news and entertainment is necessary to capture subscriber interest. In other words, rural systems cannot be solely supported by public service and commercial use of which charges are levied. Full subscriber support is also necessary.

Expansion of cable into the rural public service market has not been directly restricted by FCC regulations. More important are: 1) the indirect impact of regulations which have not been enforced (20-channel capacity and response capability); and, 2) regulations which have been designed primarily with the broadcaster in mind.

With regard to the first, requirements for response capability and 20-channel capacity were not enforced because the cable industry was competing with broadcast under adverse economic circumstances created in part by other FCC regulations designed to protect broadcasters (restriction on distant signal importation, limitation of cablecasting of sports and movies, etc.). Although the impact has yet to be felt, failure to enforce the 20-channel capacity and response capability requirements has led to the installation of reduced capacity cable systems which ultimately will restrict cable operators from providing exactly those multi-channel services which cable can uniquely provide.

With regard to the second point, cable has been treated as ancillary to broadcasting. As described in a recent House Subcommittee on Communications staff report:

> ..."it means that cable has no charter of its own -- that is is largely regulated as an appendage to conventional broadcasting. But cable television has distinct characteristics, and merits the opportunity to develop on the basis of those differences" (27-29).

Translators.[1] A number of regulations presently constrain the use of translators as a supplementary means of servicing remote households in an area-coverage broadband system. In most instances cited below, these restrictions could have the practical effect of preventing a broadband system from integrating translators into their operation.

- Translators are restricted to rebroadcasting signals from licensed broadcast stations with station approval for such rebroadcast. Thus, an owner of a translator cannot originate programs. This restriction also applies to advertising, reducing the potential of this form of financial support. More particularly, UHF translators are permitted 30 seconds per hour of still picture and recorded audio advertising. No advertising or other local origination is permitted on VHF translators. These restrictions may be contrasted to cable alone, where station approval for program transmission is not required and where local origination of programs is encouraged.

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[1] Translators are defined as broadcast stations "...operated for the purpose of retransmitting the signals of a television broadcast station, another television broadcast translator station, or a television translator relay station by means of direct frequency conversion and amplification of the incoming signals..." (Federal Communications Commission Rules and Regulations 74701).

- importation of distant signals by microwave, whether land or satellite based, is barred for translator stations (26). Thus, the distance over which signals can be imported is limited to the number of "hops" which can be made by translators before the signal degrades (a few hops at 50-80 miles per hop) (3-5). Not only is distance limited but the cost of distant signal importation is increased compared to the cost if distant signals were obtained from land-based microwave relays or satellites. Such restrictions do not apply to cable systems.[1],[2]

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[1] It should also be noted that Nevada Radio-Television, Inc. has had permission since December 1972 to use 7 and 13 gigahertz, subject to several conditions, for a television relay and translator network. The original reference is the FCC Memorandum Opinion and Order No. FCC-72-1110. The current reference is Nevada Radio-Television, Inc. 38 FCC 2nd 55525RR 2nd 1197.

- Regulations prohibit scrambling of translator signals (26-318). Thus, because these signals are broadcast over the air; they can be picked up by any television set. This may be contrasted to cable service where a fee can be charged for installation of the cable and subsequent use of it. Because of the difficulty of charging for translator use, entrepreneurs do not find installation and operation of translator stations economically attractive. Instead translator stations are usually operated by broadcasters wishing to reach locations outside their signal range, government entities or nonprofit community organizations (3-5).

As is apparent from the above, translator stations are operated primarily as extenders of broadcast systems, permitting wider signal coverage, rather than as a technology with potential in its own right. Exclusion of local origination and an inability to charge for service is likely to lead to continuation of this situation.

In urban areas, where broadcast stations are located, there are strong arguments for restricting translators, the most cogent being protection of broadcasters. On the other hand, it must be noted that the 1952 FCC frequency allocation plan, deriving its justification from the Communications Act of 1934 which called for "a fair, efficient and equitable distribution" of communications service in the United States, envisaged 2,000 television stations (27-1). In fact, today, there are less than 900 television broadcasters. Those who are underserved by this scarcity of broadcast stations are the inhabitants of rural areas (27-1).

Fiber Optics. As discussed earlier in this Chapter and more fully in Appendix D, the availability of fiber optic technology could be of great importance to the development of rural broadband systems. Not only would this technology vastly increase the number of channels that could be carried on a given line, but it also holds the promise of being cheaper than coaxial cable, which might have the effect of opening up those rural areas that have too low a density to justify the expense of conventional cable.

Here, as in connection with the above discussion of the dispute between broadcasters and cable operators, the concern is that jurisdiction over the uses of this technology might be decided without taking into account the interests of rural broadband systems. As an example, the decision might be framed largely in terms of the uses of fiber optics for long-distance transmission, with an appropriate institution assigned on this basis to have exclusive jurisdiction over its use. In turn, this could have the practical, if inadvertent, result of denying its use for short distances in low-density rural areas.

Alternatively, this jurisdictional dispute could come down to a competition between the telephone and urban cable operators — with the same end result for rural broadband systems. Competition between these two is not an immediate problem because of the dissimilar capabilities of telephone and cable television systems. If, however, optical technology provides the telephone company with broadband capabilities and the cable companies begin to offer two-way services such competition may occur.

Already there are indications that the leaders in the cable television industry will probably propose that there be two distinct services and two cables brought into each household. One service, provided by the telephone utilities, would be a switched service with a universal two-way voice and data capability. The other, operated by the cable industry, would be a distribution only, non-switched service having the specific function of carrying program material from a central point to the home.

If this were to occur, once again rural interests could be left out. Present cable operators, interested largely in expanding their market for entertainment and similar services -- which only entails one-way transmission -- understandably might be willing to retain this jurisdiction in return for assigning two-way systems to the telephone companies. Left out would be the interests of potential rural broadband system operators, who conceivably could have their right to two-way capability almost inadvertently traded away.

Discussion

Broadcast television has not developed to the extent anticipated because the economic base to support a broadcast station is larger than was expected when the regulations were formulated. As a result, rural areas are underserved with conventional television. Cable operators, who could remedy this deficiency, are restricted by regulations on the number of distant signals they can import in order to protect the few broadcasters that are located in rural areas. Translators, which could increase the coverage of independent broadcasters, are sometimes not used because the independent broadcaster may then be considered a network and the costs and benefits of possible unionization must be weighed against the benefits accruing from increased coverage.

The FCC has attempted to foster development of the unique potential of cable (especially two-way cable) by imposing a requirement for free channels for educational, governmental and public access use for systems in major market areas. Local authorities frequently levy similar requirements in granting franchises. However, these attempts to encourage development of unique services may have discouraged rather than encouraged the development of cable. This is because cable operators tend to think of public services as services to be provided without charge rather than as sources of revenue. As a result, cable operators have not contributed to the development and spread of public (or commercial) services via cable.

Because cable operators generally believe that economic viability lies in conventional television programs, they have competed with broadcasters rather than emphasized the development of unique services. If it can be shown that meeting public and commercial needs can generate revenue, attitudes might change and the result could be the development of a new type of cable entrepreneur, one who might "broker" a total system consisting of a combination of services.

As for the impact on cable of possible future legislation, one further area of current debate requires comment. At issue is whether cable should be treated as a common carrier, as telephones are. The underlying concept, as articulated in the Whitehead Report and elsewhere, is separation of the medium -- the cable distribution system -- from the message -- the program or information content. The cable operator would be similar to a telephone company, a common carrier, in that he would provide a communications system but would be barred from influencing the use made of his system. Separate entities, such as the networks, private broadcasters or other groups desiring to provide special services would rent or buy channels from the cable operator.

Regulation of cable as a common carrier could constrain the system concept as described in this report. This is because this concept assumes a combination of services and accessibility to the system by all residents (those living in relatively unpopulated regions as well as those living in more densely populated rural towns). Economic viability is based on averaging of costs across all residents so each pays the same and on the potential reduction of costs to each individual subscriber because of higher fees for institutional use which help to support the total system. If the cable operator is restricted to distribution and excluded from content, his motivation to participate in developing a viable combination of services which will support an area-wide cable plant in a low density area will be greatly reduced.

As an overall comment on regulatory constraints upon the development of broadband systems, it has been shown that these constraints, present and likely in the future, seem to represent errors of omission rather than commission. To the degree that the interests of rural broadband systems are not brought to the attention of policy-makers, it is likely that important issues will continue to be resolved as if only urban interests were involved. In the latter instance, decisions might be made which could have the practical effect of foreclosing the development of rural broadband systems before the latter even have a fair test.

Economic Constraints

A *prima facie* case can be made that the princiapl constraint on the deployment of rural broadband systems has been economic viability.[1] The

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[1] It should be noted that in the long run it will be necessary to look beyond economic constraints. To the extent that neighboring rural communities, for whatever reason, refuse to work together or share

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common facilities such as broadband systems, economic infeasibility might be said to be grounded in social factors. A similar caveat applies when jurisdictional disputes among state and local government and community groups hamper such common enterprises as these systems -- except that in this instance the cause for non-adoption might be labelled as political. While either or both of these factors could have significant influence upon the ultimate degree to which broadband systems are adopted, they are not immediately relevant to the task at hand -- which is attempting to understand why rural areas which otherwise might be willing and able to support such systems have been unable to develop them.

necessary technology has long been available, present regulations are not totally restrictive, but Trempealeau County remains the only rural area in the United States where an area-coverage system is being seriously attempted.

Data are inadequate to judge whether the belief that such systems are not ecnomically viable is valid -- or whether this belief is simply "conventional wisdom." What does seem clear is that conventional cable systems, limited to news and entertainment and having as their sole source of revenue the fees of individual subscribers, are not economic in low-density rural areas. To the extent that potential entrepreneurs and system operators continue to think strictly in terms of the traditional uses of broadband, then their negative opinion -- or, "conventional wisdom" -- will continue to be self-fulfilling in nature.

Hard data on the economic feasibility of area-wide multiservice systems must be gathered before this predominant opinion of investors and operators can be altered. Later in this Chapter an approach will be outlined by which such data can be gathered. First, however, it is necessary to describe the economic constraints to the development of rural systems as they exist and are perceived today. There are two aspects of the problem: capital for system construction and, capital for operating and maintenance costs.

Construction. Installation of a broadband communications system, regardless of the technology used, is capital-intensive and requires a large front-end investment. The costs of laying cable, providing hardware at the head-end, erecting antennas and installing translators, or constructing an earth station, are sizable. These costs can be reduced somewhat in rural areas; for example cable undergrounding will be cheaper in rural areas than in high density urban areas or may not be required. But even under the best conditions a large investment will always be required.

Unfortunately, sources of funds are extremely limited. Private entrepreneurs will not put up the necessary capital or use their conventional loan sources for rural systems because such systems are believed to be uneconomic. Two government sources which have been used to support installation of rural systems were found, but, for the reasons outlined below, neither is likely to be of significant assistance in the future.

The first of these is USDA Farmer's Home Administration Community Facilities loans under Title I of the Rural Development Act of 1972. One such loan has been made to a cooperative, the Western Wisconsin Communications Cooperative (WWCC), to fund the first phase of a county-wide cable and microwave system. As has been described, WWCC was fortunate in the timing of their loan application, having submitted it just after the Act was passed. Today, there is more competition for these funds. A successful applicant would have to justify a telecommunications system in terms of recently issued loan priorities, which are (in descending order): 1) public safety facilities; 2) health care facilities; 3) public service facilities; 4) recreation facilities; 5) new hospitals or expansion of existing hospitals; and 6) other (33).

Given the present uncertainty as to the value of broadband communications to rural areas, it is unlikely that such an application could successfully compete today for funds. The validity of such an interpretation is shown by a statement from the FmHA Administrator in correspondence to OTA: "we do not anticipate this type of loan becoming a significant part of our community facilities loan program" (17). In sum, this potential source of capital for construction of new systems is probably now a dry well in the shifting sands of uncertainty surrounding rural broadband communications. In fact, it seems unlikely that additional funding will be forthcoming for Phases II and III in Trempealeau County, which must be completed if anything concrete is to be known about the overall value of a community-based, area-coverage system.

The second government source of funds for capital construction of rural telecommunications systems is the Business and Industrial (B and I) Division, also under the Farmer's Home Administration of the USDA. Unlike Community Facilities which grants direct loans, the B and I Division guarantees loans from other lenders, such as banks. Whereas Community Facilities can help a cooperative or other non-profit community organization, B and I is a useful guarantor of loans for the private entrepreneur. One B and I guarantee for a telecommunications system was found. This guarantee was approved on behalf of Windsor CableVision, which is installing a cable system in parts of the contiguous counties of Windsor, Williamston and Plymouth, North Carolina. Although the system will initially provide commercial and educational television, the system operator, Bermey Stevens, envisions far more. Under the right circumstances, this system could evolve in the Trempealeau County direction -- but through the efforts of private industry, rather than through the non-profit cooperative mechanism. It remains to be seen whether circumstances will facilitate such evolution. The outcome will depend greatly on the ability of this one person to accomplish what no other private operator has achieved and to devise, assemble, and sell a combination of non-entertainment services that can be of economic value to his community and still pay for themselves. Before leaving this section, however, it should be noted that the B and I Division of USDA could guarantee funds for other telecommunications operators. Whether rural-based operators will take advantage of the opportunity in order to support systems which go beyond conventional television service may be unlikely in view of the prevailing opinion in the industry about the economics of these systems and such services.

Operations and Maintenance. Assuming that a broadband system exists in a community, its economic viability will depend upon revenues in excess of costs. Costs include retirement of capital debt, salaries and overhead associated with operating the system, and maintenance requirements.

Until now, revenue to cover these costs has depended almost entirely on fees from individual subscribers whether directly or indirectly collected. (An example of an indirect collection method is the use of special community tax districts to pay for translator service.) The service in return for subscriber fees generally has been limited to network or educational television, possibly supplemented by channels dedicated to special use (e.g., public and government access) if required by FCC rules. Fees are typically in the order of $5/month. Under these conditions, the number of subscribers per unit area will determine the economic viability of the system.

This economic picture, however, can change radically if revenue can be derived from public or commercial services. The concept is best illustrated by the proposed Trempealeau County project in which the schools will each pay $9000/year to use the system. The benefit for the schools is expected to be more effective use of teachers and reduced transportation costs. The broadband system will be used to link teachers and students across schools for special classes, which will eliminate the extensive shuttling of students from school to school which now takes place.

It is this aspect, of providing a cost-effective alternative to manpower intensive and transportation intensive solutions to rural problems, which has not been adequately explored. In fact, it is ironic that the FCC requires free cable channels for government, educational and public access use, in major market areas. If these were used effectively (they are not), the community might well be willing to pay for value received.

Discussion. If the costs and revenues of a rural broadband system depend solely upon conventional television programs in sparsely populated rural regions, then a cautious stand toward economic viability is justified. What remains to be tested is the value of broadband communications as a substitute for manpower, transportation or other alternatives in providing health, education, governmental and commercial services to rural areas. A fair test must include revenues to the system based upon the value of these services, in which case the fees to be charged might nearly equal the next most costly alternative. If broadband communications then can provide a benefit equal to or greater than that provided by alternatives, broadband would be the technique of choice for providing the service. In turn, the fees paid by institutions or the community might allow the fees charged to the individual subscriber for news and entertainment services to be lowered and thus affordable by most residents. Inquiries conducted in the course of this study indicate that this test has not yet been made.

Summary Of Findings

In preceding sections of the Chapter, a broadband communications system was defined, two illustrative case studies were described, and constraints to system applications in rural areas were identified. Findings are briefly summarized below.

A rural broadband system is a community-wide communications network, available to all residents and many institutions. The system may be used to meet health, education and other social service needs, facilitate government and administrative transactions, and serve commercial enterprises as well as provide network TV and entertainment. The particular services are derived from an assessment of community needs in which it is determined whether broadband is the most cost-effective method for filling those needs. Significant fees are charged for public service and institutional use of the system. These fees are justified by savings made elsewhere (e.g., the salary costs of hiring more teachers.) Institutional and public service support of the system reduces installation and subscriber costs for individual users. The combination of services leads to economic viability.

The Trempealeau County project most closely illustrates what is meant by the system approach. A county-wide cable and microwave system available to all residents is planned. An institution, the schools, will use the system in hopes of improving the quality of education and saving dollars associated with teacher salaries and transportation of pupils between schools. While an early feasibility study showed that a conventional individual subscriber supported cable system would not be economically feasible, the combination of individual subscribers and institutional use is expected to result in economic viability. It should be noted that each [illegible] will be charged a signficiant fee -- $1000 for installation and $9000 p[illegible]ear for two-way use -- compared to a $20 installation fee and $5 yearly user charge for individual subscribers.

The Spartanburg, South Carolina experiment illustrates multiservice use of a broadband system. Three experiments are being conducted with Spartanburg's two-way cable system. These are in adult education, training of day care personnel and streamlining the processing of applicants for multi-agency programs. The costs and benefits of two-way broadband vs. one-way broadband, vs. meeting these needs by more conventional means are being compared. Although Spartanburg is an urban rather than a rural community, these same services are needed in rural settings. National Science Foundation support for the project will end when the experiments are over in about three years. However, the potential is there for evolution into a system demonstration. If broadband proves to be a cost-effective method for providing these services, they could be continued by other funding mechanisms.

Given the high potential of broadband to meet rural needs, it is noteworthy that there have been so few applications providing services other than conventional television. Technology is not limiting. FCC regulations do provide some constraint. For example, relaxation of restrictions on translators, so that they could rebroadcast signals received from ground or satellite-based microwave relays, would encourage wider use of this technology. For cable alone, regulations restrict cable transmission of commercial television but do not inhibit use of cable for public services or institutional use.

The primary constraint on wider use of broadband in rural areas is economic. However, it is unclear whether this constraint is actual or perceived. While the low density of rural populations makes use of broadband to provide conventional television economically less attractive than in urban areas, the same low density could well favor it for public service and institutional use. However, lack of knowledge on how to put together an effective combination of services, inadequate data on their value which makes it difficult to determine an appropriate charge for such uses, and inadequate sources of capital have inhibited rural applications.

The Need For System
Demonstrations

Tests of the system approach to broadband communications have not been made in rural areas. What are now needed are demonstrations to see whether this approach works. As has been pointed out (34-II-46):

> "the argument developed in much of the literature -- that as systems become profitable they will naturally develop public service programs -- simply has not held true. Many profitable systems have never instituted such programs. Other systems that have penetrations well above the expected profit-generating point of 40 percent, discontinued their programs (e.g., Wilmington, Delaware at over 60 percent, Santa Rosa at over 80 percent). It is clear that if natural experimentation in social and/or public service delivery is to develop -- even in a technologically limited mode -- it will have to be developed by agencies other than cable systems."
>
> "...the development is not likely to come from those municipalities where cable exists. In general, they are not large enough to have the research or technical capabilities necessary to establish a comprehensive delivery system."

The system concept as developed in this report does not assume that the public service aspects of broadband communications are economically unsound and therefore require subsidy by more profitable entertainment programs. Instead, the opposite hypothesis has been advanced. Public and commercial services figure prominently in the economic base for the system. However, as pointed out in the above quotation, broadband systems providing public services as well as conventional television have not spontaneously evolved.

In view of past experience, they are not likely to evolve without Federally assisted demonstration programs.

On the other hand, a massive government program to support rural broadband systems seems premature. Not enough is known about the detailed nature, feasibility, and value of such systems to enable their widespread deployment by means of routine and standard operating programs. Demonstration programs are a necessary intermediate step.

Before describing an approach to implementing system demonstrations, it is important to clarify what is meant by a demonstration and distinguish it from an experiment.[1] An "experiment" implies careful selection of variables, a rigorous evaluation protocol and a limited span of time over which the experiment will operate. An experiment is generally superimposed on a community. It is not intended to be self-supporting and generally is heavily or entirely supported by Federal funds. Public service applications of telecommunications have largely been experiments, not demonstrations. The objective has usually been to determine whether it is possible to use broadband to provide the service in question. There has been relatively little emphasis on evaluating how effective broadband is compared to other methods or whether it is less costly. When the experiment is over and Federal funds are withdrawn, the community usually (but not always) cannot, or does not provide funds to continue the service.

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[1] Definitions of "experiment" and "demonstration" vary among researchers in different fields. It is recognized that these terms as used in this report may be used differently by others.

In contrast, the intent of a "demonstration", as used here, is to test whether entertainment, public service and commercial uses of broadband communications can be combined so as to produce a system which is economically viable and which meets the needs of a whole community rather than one or a few subpopulations within it. The particular services must be tailored to the specific and individual needs of each community because different services will have different cost effectiveness ratios depending on the demographic, socioeconomic and institutional characteristics of the community.

Associated with the concept of a demonstration as used in this Chapter, is the consequence that a certain amount of experimental rigor may be forfeited. For example, the ideal community for a demonstration is one which has indicated a strong desire for the service as shown by its assembling knowledgeable personnel, developing a preliminary system concept and perhaps investigating some of the economics of the situation. However, the community may not be the one which an experimenter would select after careful consideration of all communities in which the experiment might be conducted. Nevertheless, the success of a demonstration (as contrasted with an experiment) is more likely to be related to a widespread community desire for the service than to experimental needs.

It is important to distinguish this report's use of the term "demonstration" from another use sometimes made of it. Thus, demonstration sometimes refers to construction of hardware to see if it will work or could be used in a particular application. There have been many such demonstrations in the field of broadband communications. However, under the definitions used here, these would be hardware experiments, not demonstrations.

It should not be assumed that a finding of this study is that there is no further need for experimentation. However, such organizations as the National Science Foundation and the Department of Health, Education and Welfare are fulfilling this need. The need for demonstrations and the means to bring them about has been less adequately explored and hence are the subject of most of the rest of this Chapter.

An Approach To Implementation Of System Demonstrations

As to what broadband services may be included in systems demonstration any or all of those discussed in Chapter II might be candidates. In addition, consideration might be given to comparison studies of transportation demonstrations such as the Rural Bus Program in rural counties with similar characteristics to those which are the sites for broadband communications demonstrations.[1]

Turning to the specifics of designing system demonstrations, there are financial, technical and institutional aspects which will vary with the characteristics of the rural areas in which the demonstration is to take place. A preliminary framework has been developed based upon the three types of rural counties described in Chapter III.[2] In brief, it will be recalled that these are:

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[1] The importance of these comparisons lies in the fact that there are substantial funds for transportation demonstrations in rural communities. Rural communities may become prematurely committed to transportation options (such as shuttling students back and forth among schools for special classes) when communications options might be more cost-effective.

[2] As stated in Chapter III, the individual county has been used as the unit of analysis because most statistics have been gathered on this basis. In practice, a rural broadband system could take in the area of all or parts of several counties, which could also mean that more than one category of county might be included in a single system. Especially

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if these sytems are to be underwritten in part by public service users, such as schools, it is more likely that the boundaries of the broadband system will be coterminous with the geographical boundaries of these administrative districts, which in recent years have increasingly become regional rather than following county lines. This does not invalidate the general point that has been made concerning the necessity for matching a system to the characteristics of the individual rural area being considered.

- Turnaround Acceleration -- counties which are usually adjacent to metro counties, have accounted for 62% of the net migration gained by rural areas in the 1970's and are characterized by growth in the service sector of the economy.

- Turnaround Reversal -- counties which are usually not adjacent to metro areas, have not grown as rapidly as Turnaround Acceleration counties (but whose growth in the 1960's and 1970's is significant because it followed decades of declining population) and are characterized by growth in the manufacturing sector of the economy.

- Declining -- counties which account for 25% of all rural counties and are generally not adjacent to metro counties, are still showing net outmigration and in which employment opportunities in service or manufacturing have not kept pace with losses in agricultural or mining jobs. Elderly and young people typically account for a disproportionately high percentage of the population.

As indicated in Chapter II, revenue sources to support broadband communications are likely to also vary with the individual community. In general it can be said that:

- for the rapidly growing, service-oriented Turnaround Acceleration counties, business and commercial services are a potential source of revenue. Some of these counties are also characterized by a high proportion of couples of child-bearing age, whereas others contain a significant proportion of relatively well-off retirees. Regardless of which (or both) of these populations are predominant, the educational attainment and relative well-being of these populations are likely to result in a demand for public services (in such areas as education and health) together with a possible willingness to pay for those public services that could be supplied by broadband.

- for the less rapidly growing Turnaround Reversal counties, characterized by growth in manufacturing jobs, business and commercial uses of telecommunications are less likely to be an important source of system revenue. In these counties, as in the instance of Trempealeau County, non-subscriber revenue is likely to depend upon fees paid by the local governments for use of the system for health, education and similar public service purposes.
- in Declining counties, the economic base is likely to be too depressed to enable paying for the incremental improvements broadband might bring to health, education, and other public services. In these counties, dependent on outside governmental assistance for the upgrading of public services, selection of broadband as a way to provide these services is more dependent on Federal decision as to the cost-effectiveness of this approach than in the other two types of counties.

Assuming that a decision might be made to provide Federal assistance for these demonstrations, the following basic steps would need to be taken:

1. designation of a Federal agency (or agencies) to administer the program, collect data and evaluate results;

2. provision of a funding mechanism(s);

3. dissemination of the system demonstration concept and identification of potential demonstration sites.

Responsible Agencies

In considering agencies that might be assigned responsibilities for system demonstrations, the need for an effective planning organization at the local level should not be overlooked. In some areas, such as Trempealeau County, cooperatives may be so pervasive that they can unite most of the population and the local government in the organizational effort necessary to plan for and implement a broadband system. In others, something akin to the multi-county planning districts being established in several states might provide technical assistance and direction.[1]

At the Federal level, it is clear that a great deal of attention will have to be given to devising an effective means of direction and coordination. Listing only a few of the possible institutional mechanisms, an inter-agency task force could be appointed to oversee federal participation in demonstrations. Or, a policy board comprised of representatives from executive agencies and rural and industry interest groups could be designated to design and supervise demonstrations in accordance with broad legislative guidelines.

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[1] Although the concept of multi-county development districts in rural areas is still relatively new, in some states they could be of direct assistance to rural communities wishing to consider broadband systems to meet public service needs. In South Dakota, for example, one planning district indicated that it intended to look into alternative ways of supplying county services in rural and sparsely settled areas. In other states, these districts have provided technical assistance and consultation in such areas as communications, law enforcement and school district reorganization. For additional details see The Role of Multi-county Development Districts in Rural Areas (U.S. Department of Agriculture, August 1975, Washington, D.C.).

It is beyond the purview of this study to examine fully these and other alternatives. The approach taken here is to outline one simplified alternative in which oversight is provided by existing Congressional committees (possibly with the assistance of OTA, as described in the final section of this Chapter).

Many agencies have been involved in telecommunications research, including NASA and HEW. However, there are three, for the reasons described below, that might be initially considered for major roles in the demonstration phase. These are: 1) the National Science Foundation (NSF); 2) the Department of Commerce; and 3) the Department of Agriculture.

In recent years, the National Science Foundation has taken the lead in "systematic experimentation" (34-II-50) with its Phase I design and Phase II implementation studies of public services and broadband communications. Although these projects are not necessarily rural, conduct of system demonstrations could be a natural follow-on to these efforts. An appropriately staffed project office within NSF might be established to head up the coordination, data collection, and evaluation of the overall federal program. Additionally, because of its specific experience in the Spartanburg project and other experimental efforts with public service applications, NSF might also be responsible for one of the three major elements to be included in system demonstrations (public service applications; the other two are business and commercial use, and impact on rural life).

Dissemination of "how to" information and collection of data on business and commercial applications might be undertaken by the Department of Commerce. In this connection, it should be noted that the Economic Development Administration, within the Department of Commerce, recently funded a study to help "in determining national policy regarding the future course of telecommunications research and development as related to rural economic development" (35-1).

The Department of Agriculture is presently a source of loans and loan guarantees (under the Rural Development Act of 1972) for broadband projects as well as being an authoritative source of detailed knowledge on rural development in general and potential demonstration sites in particular. A significant part of this project must be evaluation of the impact of expanded telecommunications services on rural growth and on the distinctive characteristics of life (both positive and negative) in rural areas. The Economic Research Service, which was a major source of information for Chapter III, might be considered for involvement in the project.

In addition, as described later, the Department of Agriculture, through its Extension Service, might play a significant role in introducing the system demonstration concept to potential rural sites.

Funding Mechanisms

There are two aspects of funding which must be considered: 1) capital for broadband equipment plant; and 2) operations and maintenance resources which are needed for identifying demonstration sites; developing software and materials for public service, commercial and other system demonstration uses; operating and maintaining the system; and conducting evaluations.

For capital construction of telecommunications plant, an existing source of funds is Community Facilities loans under Title I of the Rural Development Act of 1972.[1] As discussed earlier in the Chapter, one such loan has been approved for installation of a cable/microwave system in Trempealeau County, Wisconsin. However, as has also been pointed out, loans for telecommunications systems are not expected to become a significant part of the Community Facilities loan program. Congressional action will therefore be required if further assistance to broadband systems through this program is to be possible. In this connection, it should be noted that broadband systems providing public services might qualify under the top three of the six recently issued priorities for Community Facility loans as follows:

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[1] Steven R. Rivkin, formerly counsel to the Sloan Commission on Cable Communications, has suggested that Rural Electrification Administration (REA) funds might also be used for these purposes. In Rivkin's view, a 1962 change to the REA act might be construed as providing sufficient authority to this agency to grant loans to support rural cable service (5-12).

1. public safety facilities (if the system demonstration includes fire and burglar alarm or law enforcement administration);

2. health care facilities (if the system demonstration includes health provision); and

3. public service facilities (if the system demonstration provides or extends the services normally provided in courthouses or community buildings).

Under the above priorities, the broadband equipment might become the "facility" in lieu of a conventional building, ambulance or piece of firefighting equipment. Because a properly designed system would provide many different services rather than one, it could compete for funds under several different categories of priorities rather than one and thus might compete effectively with more conventional "community facilities" for loans.

The second category of funds required is for operations and maintenance of system demonstrations, which has been broadly defined to include site selection, technical assistance in setting up public service programs and evaluation of results, as well as system operation and maintenance. These funds should be provided under the aegis of the lead agency conducting the system demonstrations -- the National Science Foundation. There are two types of mechanisms to be considered: outright grants and loans.

In favor of outright grants, it can be argued that the system demonstration concept is novel and unproved. Therefore, it is unlikely that there will be applicants for loans, either direct loans or more especially loan guarantees. In addition, the program might be considered to be in the national interest and to ensure that it takes place, grants are both justified and necessary. In any event, even if grants should be decided upon, a system demonstration, if successful, should be transferred to a self-supporting basis. Concerring the desirability of loans instead, it is possible that these might induce a closer look at the economics of each candidate system demonstration site. One possibility which might be considered, if the loan approach is selected, is to use FmHA B and I Division loans for the business and commercial parts of each demonstration.

The above listing is intended only as a brief indication of the factors to be considered in deciding between loan and grant mechanisms. This decision, in any event, clearly would be of lesser priority than the basic issue as to whether the government should encourage and assist system demonstrations.

The level of resources required to fund both capital construction and operations and maintenance for system demonstrations is difficult to estimate.

Factors such as whether loans are direct or only guaranteed, whether an existing broadband plant might be used or whether one must be built, will produce large differences in program cost. However, in order to provide a rough indication as to possible costs, the following assumptions have been made:

- Assume that four system demonstrations will be funded -- two each in Turnaround-Acceleration and Turnaround-Reversal counties. (Initially, demonstrations might not be practical in Declining counties. The state of public services in these counties might be such as to require basic rehabilitation before broadband use could provide any measurable benefit. In any event, the funds and level of effort required would exceed the resources contemplated to be available for the kind of system demonstrations here discussed).

- Assume that four systems require funds for capital construction and that these will be direct loans. The estimated cost of the Trempealeau County system is 5.5 to 6 million dollars (8-3) and is taken as the estimate of the capital cost for each system. Thus, capital costs for four systems, not including debt service costs, may be estimated at $24 million.

- Assume that operations and maintenance costs will be covered by grants. The Spartanburg project will cost slightly more than $1 million over a period of three years or $300,000/year. However, Spartanburg is a phased demonstration. Had it not been phased, costs could have been considerably higher. For these reasons, projected costs for each system demonstration have been doubled to roughly $600,000/year. Assume that each system demonstration will run for three years. Thus, for four demonstrations: 3 x 4 x $600,000 = $7,200,000.

- Assume that costs for preliminary studies to select system demonstration sites and plan all four demonstrations will total about $2 million.

- Thus, for a five-year program (two years for preparation plus three years for implementation and analysis), the following costs might be incurred:

Capital construction	$24 Million (loans)
Operations and Maintenance and Evaluation	$7.2 Million (grants)
Preparation	$2.0 Million (grants)
Per year grant costs:	$1.8 Million

For purposes of comparison, it is interesting to note that Federal expenditures for telecommunications research based on spending levels by major agencies over the past year is $12.6 million annually. This is shown in the table on the following page.

If system demonstration construction costs are funded through loans, it can be seen that the per year costs of the program ($1.8 million) are not greatly different in magnitude to that amount presently spent by each of the major Federal agencies in recent years.

TRENDS IN FEDERALLY CONTRACTED TELECOMMUNICATIONS RESEARCH*

(reproduced from Reference 35, pg. 76)

National Institute of Education	$ 5,000,000
Health Resources Administration	500,000
National Library of Medicine/Lister Hill	2,000,000
Department of Commerce/Office of Telecommunications	1,700,000
Housing and Urban Development	400,000
Federal Communications Commission	1,000,000
Office of Telecommunications Policy	1,000,000
National Science Foundation	1,000,000
Department of Defense	(not available)
TOTAL	$12,600,000

* These figures reflect approximate funding trends for yearly expenditures by these agencies over the past three years.

Identification Of Potential Sites And Dissemination Of The System Demonstration Concept

Only one criterion might be universally applied to all candidate rural areas which might wish to serve as a system demonstration site. That is, that there must be a high degree of community support for the system. Institutional and public service use of broadband is novel and unfamilar. Individuals within the community in question will have to work together, as they have in Trempealeau County, to define those collective needs which can be best met through broadband services. They will also have to be capable of recognizing the economic value of these services and support the system accordingly, (e.g., tax monies used to support schools can also be used for educational services offered through broadband communications). Without such commitment, it is unlikely that a system demonstration will work.

A way to expose communities to the program is required. One mechanism is the trade press through magazines such as Rural Electrification. A more organized mechanism is use of rural extension agents, who form a wide network under the Department of Agriculture's Extension Service. These agents could play a key role in describing the program to communities and assisting in the identification of potential demonstration sites.

Types of Sites

Demonstrations should be conducted at more than one kind of site. As a conclusion to this section, note is made of two potential types of demonstration sites. One type illustrates cooperative ownership and two examples of potential sites are described. The other is that of the private operator and one example is provided. These examples have been included to provide specificity in what would otherwise be an abstract discussion rather than to suggest that these sites must be selected for system demonstrations.

The Trempealeau County project, investigation of which gave rise to development of the system demonstration concept, illustrates many facets of a system demonstration especially as it may be conducted under the aegis of a cooperative. Phases II and III of the Trempealeau project remain to be completed.

A second example of the cooperative type of demonstration is a project investigated by the Blue Ridge Electric Membership Corporation for Lenoir, North Carolina. Blue Ridge Electric undertook a study of providing cable TV as a cooperative member service in 1973. A very careful feasibility study (36, 37) indicated that cable television costs compared to subscriber interest showed that the project was not justified. However, the project was oriented to conventional TV and it will be recalled that a similar study at an early stage in Trempealeau County also indicated that simply providing conventional TV was not economic in that county. The institutional involvement of the schools was required to move the Trempealeau project towards economic viability. So far, use of public services to support a system in Lenoir has not been investigated.

The efforts of Windsor Cablevision to bring cable to three rural towns (Windsor, Plymouth and Williamston) in three North Carolina counties, which has been briefly described elsewhere, illustrates a second type of demonstration project. This example differs in motivating force from Trempealeau (private operator rather than cooperative) and is a long way from being a system demonstration. However, the cable operator is interested in providing a system which is much more than a medium for conventional television. It will also be recalled that a Department of Agriculture B and I loan guarantee has been approved for this project.

Investigation Of The Impacts Of Widespread Implementation Of Telecommunications In Rural Areas

Changes brought to rural areas through broadband might be positive or negative, depending on the attitudes and preconceptions of an observer. Increased migration (without improved services from broadband) has already strained the resources of some rural communities. Whether broadband communications, if it exacerbates this trend, is an overall good is an area deserving considerable attention. Thus, definition of impact areas, and development of a plan for evaluation of the potential positive and negative consequences of widespread rural telecommunications systems, should be an integral part of any system demonstration program. While detailed consideration of this topic is beyond the scope of this study, the following is a representative listing of the impact areas that are pertinent. It will be noted that some of these impacts, being national in scope, could be largely hypothetical unless broadband systems were deployed in large numbers.

Population balance

- change in the proportion of people living in metro and nonmetro areas.
- shift from current situation in which greatest nonmetro growth is occurring in counties adjacent to metro areas to one in which rapid growth occurs in more remote rural counties.
- change in distribution of age groups and socioeconomic characteristics in metro areas and in the three types of nonmetro areas (Turnaround Acceleration, Turnaround Reversal and Declining).

Economic

- change in number, type and level of employment opportunities in nonmetro as compared to metro areas.
- movement of corporation headquarters or branches to nonmetro areas -- effect on metro economic base.

- market aggregation based on criteria other than geographic location or transportation access -- for example, availability of broadband communications system.

Social

- quality of education in metro and nonmetro areas.
- quality of health in metro and nonmetro areas.
- overall quality of life in metro and nonmetro areas.

Institutional

- effect on network, commercial, public broadcast and educational TV.
- effect of a possible change from a single nationwide communications network based on the telephone to a two-tier broadband network -- a national network and a community-based local network.

Transportation - Telecommunications Tradeoffs

- impact on petroleum usage.
- impact on automobile and other transportation industries.

Longer Term Impact Areas

- changes in work patterns (work at home will affect office building construction and commuting; teleconferencing will affect the convention hotel industry, etc.)

A Future Course Of Action If System Demonstrations Prove Successful

If system demonstrations prove the feasibility of community-wide broadband systems to meet a variety of rural needs and if it is judged that the positive and negative impacts of such systems are, on balance, favorable for national growth and development, then funding services for implementing such systems on a broad scale might be sought. One solution might be to establish a Federal program modelled on the Rural Electrification Administration which brought electricity and telephone to rural areas through low cost loans. However, in the case of rural telecommunications systems, a more flexible approach involving several different funding mechanisms might be considered (and evaluated further during the system demonstration phase).

The reason why a more flexible approach might be called for lies in the widely varying economic characteristics of rural America. Employing the Turnaround Acceleration, Turnaround Reversal and Declining county categories used earlier as a framework for analysis, it can be seen that these three classes of counties might require different funding mechanisms for system construction, as well as different levels of government involvement. This concept has been discussed previously and is diagrammed in the table below:

County Type	Federal Financing Mechanism
Turnaround Acceleration	Guaranteed Loan
Turnaround Reversal	Direct Loan
Declining	Government Subsidy

Turnaround Acceleration counties have a well-developed economic base, opportunity for commercial and business uses of telecommunications, and expanding need for educational, health and other services. Of the three classes of counties, these should be the most attractive to private entrepreneurs. Guaranteed loans, such as those available from the Business and Industrial Division of USDA, could be an adequate funding mechanism to induce development of broadband systems if their potential is shown in a system demonstration program.

The less rapidly growing, manufacturing-oriented Turnaround Reversal counties could be less attractive to the private entrepreneur. Business and commercial uses of telecommunications are less likely in these remote counties. While the need for public services may be substantial, the problem of convincing the community of the value of meeting these needs via telecommunications is likely to be great. Capital will be harder to find, and thus direct loans such as those for Community Facilities under Title I of the Rural Development Act of 1972 could be needed to help fund these installations.

For Declining counties, system revenues might not be sufficient to pay back loans of either category. In these counties, improvement of public services might require outright grants or subsidies. These services cannot now be supported by the community and it is unlikely that broadband will be very much more cost-effective than conventional methods. However, telecommunications could permit upgrading service where other methods fail. For example, through broadband, the services of a doctor could be brought to Declining counties where inducements to physically bring him there have failed. In this way, the effectiveness of Federal funds spent in Declining areas could be increased via broadband.

Turning from financial to institutional mechanisms, a similar matrix can be constructed. As shown below, different types of owner/operators may be appropriate for, or attracted to, developing systems in the three types of counties.

County Type	System Owner/Operator
Turnaround Acceleration	Private Industry
Turnaround Reversal	Rural Cooperative
Declining	Private Industry/Local Government

Private industry, given a source of capital, should find Turnaround Acceleration counties an attractive market, provided there is community commitment to the system and services can be charged appropriately.

Turnaround Reversal counties, unlike Turnaround Acceleration counties, are typically remote from metro areas, and truly rural. Many such counties have active and vigorous rural cooperatives, oriented to non-profit membership service. As described elsewhere, rural cooperatives played a crucial role in bringing electricity to rural areas, a situation not without parallel to bringing broadband to the same communities.

For Declining counties, the de facto owner/operator of a system might be the Federal government. Although private industry or a local government may "own and operate" the system, in these counties sizable Federal support may be necessary.

The two tables already presented can be combined into a single table. The Trempealeau County project would be located on the second line of this table.

County Type	Federal Financing Mechanism	System Owner/Operator
Turnaround Acceleration	Guaranteed Loan	Private Industry
Turnaround Reversal	Direct Loan	Rural Cooperative
Declining	Government Subsidy	Private Industry/Local Government

Trempealeau County illustrates the use of a direct loan by a rural cooperative to facilitate installation of a broadband system. Unfortunately, Trempealeau County is a unique project and it is not likely that additional funds for broadband systems will be available under Title I of the 1972 Rural Development Act, absent Congressional action.

Trempealeau can be roughly categorized as a Turnaround Reversal county. For Turnaround Acceleration demonstrations, the B and I Division of USDA could be a source of funds. Specific Congressional direction might be required, however, to earmark some of these funds for systems demonstrations.

For Declining counties, no Federal funding mechanism is readily apparent. The criteria for USDA Community Facilities loans or Business and Industrial loan guarantees would exclude such counties. A new Federal mechanism might be required to support broadband systems installation in such areas.

Previous Legislative Initiatives And Findings From Other Studies

Rural applications of telecommunications have interested executive branch agencies and the Congress over the last several years. Treatment of the problem has ranged from recognition that market forces may not be sufficient to bring broadband communications to rural areas to suggestions that resources should be made available to fund rural projects on a broad scale. The purpose of this section is to compare the system demonstration approach to other approaches which have been proposed. To set the framework for this comparison, salient characteristics of the system demonstration approach are summarized below:

- the approach is based on the finding that the benefits and costs of using broadband systems to meet rural public service needs and to provide commercial services have not been adequately explored.

- it is assumed that public service uses should "pay their full share" based on value received. The cost of providing these services by broadband may provide the same or greater value at roughly the same cost as by more conventional methods, or make possible services which would simply not exist otherwise -- for example, full medical services cannot be provided if no doctor will locate in the area.

- it is assumed that public services in rural areas, if paid for appropriate to value, will contribute to the economic feasibility of a broadband system. Fees for public services and for commercial use may make a broadband system economically viable when such a system would not be economically viable if income were based solely on subscriber fees for conventional network and educational television.

- it is assumed that a broadband system providing public and commercial services as well as the news and entertainment of conventional broadcast could economically serve all residents in a given community. However, the feasibility of this approach must first be demonstrated. Not enough is presently known about how to assemble such systems or about what kinds of services should be provided in areas of differing demographic and socioeconomic characteristics. In the absence of such knowledge, large scale Federal assistance programs making broadband services widely available might be premature: a large number of systems could be implemented which may not be economically viable whereas, with more knowledge of likely costs and revenues, such systems could be established on a sounder footing.

- it is assumed that if the feasibility of broadband systems which bring public and commercial services as well as news and entertainment to rural areas is demonstrated, different funding mechanisms might be used to bring these systems to rural areas on a broad scale. Depending on the characteristics of the rural community (e.g., Turnaround Acceleration, Turnaround Reversal or Declining) the appropriate Federal funding mechanism could vary from loan through guaranteed loan to outright grant or subsidy.

Several recent studies and legislative initiatives are summarized below. The intent is to indicate the different types of approaches for bringing broadband communications to rural areas, so that these may be compared to the system demonstration concept. Thus, illustration of similarities and differences rather than comprehensiveness is the objective here.

Whitehead Report (28)

One of many recommendations for developing a national policy for broadband communications contained in the Whitehead Report was that broadband communications should be made available to rural residents and the poor. To prevent the possible tendency of cable operators to limit their services to affluent areas, the report suggests that franchising authorities require that service be extended to all parts of a franchise area.

The Whitehead Report notes that a number of services such as vocational training and public health information could be provided by cable and suggests that the Department of Health, Education and Welfare investigate the feasibility and cost of using cable for these purposes. Commercial uses of cable were not considered in the Whitehead Report nor is there exploration of the relationships between public services, commercial uses and conventional programming. The primary interest seems to be on parity of programming and other information services with those available in more urbanized areas. The report notes that "free market incentives of cable operators may not be adequate to meet certain national policy objectives, such as the widespread availability of information" (28-46).

Significantly, the Whitehead Report was concerned with outlining a national broadband policy for the long-range future, rather than with the problems of rural areas which might be met by broadband communications today. Thus, it is not surprising that the Report does not consider the lack of present-day broadband services in rural areas a major problem. Instead, the Report suggests that the situation should be monitored by the Secretary of Housing and Urban Development and the Secretary of Agriculture. Then, if the problem becomes significant in the future, "the Government should take affirmative action to assure a basic level of broadband communications service for residents of outlying rural areas" (28-46).

Finally, the Whitehead Report indicated a need for demonstration programs and suggested that different services be aggregated and the costs shared. Further detail was not provided. The Report stated (38-59):

> "...there is a chicken and egg problem hampering the development of many valuable services that might be commercially viable. The demand for these services depends heavily on their availability, yet few potential suppliers are willing to accept the risk of developing new services without significant evidence of a market demand for them. Similarly, while each new cable service would require relatively expensive special facilities if offered alone, these services can be aggregated and the requisite facilities can be combined so that these costs can be shared, but no one has emerged to lead and coordinate such a joint effort."

S. 1219, H.R. 5319 and H.R. 244 (38, 39, 40)

These bills, introduced in 1972, 1973 and 1975, respectively, exemplify the idea of making low interest loans available for the development of rural cable systems. S. 1219 was introduced by Senators Ted Stevens and Mike Gravel and proposed federal low-cost, long-term loans for low density areas. Co-ops would also be authorized by such loans. H.R. 5319 was a similar bill. More recently (14 January 1975), Representative Downing introduced H.R. 244.

Like H.R. 5319, H.R. 244 provided for 35-year, four percent loans to "eligible cable television systems" (40-2), which were defined as those which "can reasonably be expected to pass less than a system average of sixty potential consumers per linear mile during the first five years of its operation" (40-2).

Cable Television: Promise Vs. Regulatory Performance

This report was prepared by the staff of the Subcommittee on Communications of the House Committee on Interstate and Foreign Commerce and was published in January 1976. It contains an analysis of the problem of providing broadcast and cable services to rural areas (27-55ff.). The study notes that present broadcast service in low density areas is inadequate compared to that in more densely populated areas and that the threat of cable to local broadcasters in low density markets has not been proved (27-55, 56). Like the bills above, the report suggests low cost loans (and technical assistance). However, citing the Denver Research Institute study (3), the report notes that cable cannot economically serve very low density areas and therefore includes translators as well as cable in the loan program. The enabling legislation would be called the Rural Telecommunications Act and it is proposed that the Office of Telecommunications in the Department of Health, Education and Welfare administer the program.

Long-term, low cost loans have also been proposed by others, notably Rivkin (5-3) and the Cablecommunications Resource Center (35-95). The last study is discussed in more detail later.

Comment

Unlike the Whitehead Report, the bills and the study described on the preceding pages assume that broadband communications should be brought to rural areas today. They suggest that the problem can be solved in a manner paralleling the Rural Electrification Act of 1934 which enabled the spread of electricity and telephone service to rural areas. However, the parallel between these two situations may not be as exact as it appears. For cable, content is all important whereas the consumer supplies the uses for electricity or the content carried by telephones. In other words, is it simply the risks associated with bringing broadband services to rural areas which have prevented the entry of private entrepreneurs into the rural market? Or, as suggested in this study, is it their failure to understand the necessity for themselves becoming directly involved in arranging for content to be provided by these systems (i.e., the full range of services necessary to make rural systems economically practical)? In sum, simply helping an operator to secure funding for a system might not be enough to enable the system to have a fair chance of success.

Regardless of the answer to the last question, it should be noted that the emphasis in these bills and the Subcommittee study is on increasing the parity between rural areas with regard to network and public broadcasting, rather than on bringing public services to rural areas. Thus, even if these similar bills were implemented and broadband systems were successfully brought to some rural areas (inclusion of translators would increase the likelihood of success), it is doubtful whether public services would be provided automatically without a specific program to accomplish this objective. As was noted previously (see preceding section on system implementation), provision of public services does not tend to occur as cable systems become profitable.

H.R. 4564, S. 1257 and H.R. 9630 (41, 42, 43)

The titles and dates of introduction of these bills are:

- H.R. 4564 - Telecommunications Facilities and Demonstration Act of 1975 introduced March 10, 1975 by Mr. Staggers.
- S. 1257 - Telecommunications Facilities and Demonstration Act of 1975 introduced March 20, 1975 by Senator Magnuson.
- H.R. 9630 - Educational Braodcastirg Facilities and Telecommunications Demonstration Act of 1976 introduced January 21, 1976.

The first two bills are identical and the third elaborates on them. The bills are of interest because they propose:

> "To extend the Educational Broadcasting and Facilities Program and to provide authority for the support of demonstrations in telecommunications technologies for the distribution of health, education, and public or social service information and for other purposes" (43-1).

In supporting the need for demonstrations and specifically identifying public service applications, these bills relate directly to the findings of this report. Referring to the most recent bill, H.R. 9630, $1 million would be authorized for the remainder of FY 76 and $250 thousand for the transition quarter ending September 30, 1976 to "demonstrate innovative methods or techniques for utilizing nonbroadcast telecommunications equipment or facilities" (43-7) for "transmission, distribution and delivery of health, education, and public or social service information" (43-6). The bill permits diverse "nonbroadcast" technologies (such as satellite, cable and fiber optics) and is clearly oriented to service demonstrations rather than hardware construction (44-8). The Committee Report on the bill states that "the demonstration program is intended to respond to local and community initiatives in generating proposals" (44-8). The responsible agency would be Health, Education and Welfare.

It should be noted, however, that these bills are not restricted to rural areas. In fact, because the funds would be used for demonstrations on existing systems, the sites for such projects would most likely be urban areas. In addition, these bills are not system-oriented in that they apply only to the public service aspect of telecommunications systems.

Telecommunications Technology Act of 1975 (H.R. 9289) (45)

This bill was introduced by Harley Staggers, Chairman of the House Interstate and Foreign Commerce Committee. Like the preceding bills, it was not specifically directed to rural areas, and it authorized demonstrations. However, unlike the others, this bill did not limit demonstrations to health, education and social service information but is broader in scope. The bill cites the need to evaluate both feasibility and value of new telecommunications technology. A specific agency is designated, the Department of Commerce, and it is suggested that a Bureau of Telecommunications be established to conduct demonstration projects or support such projects conducted by other agencies (35-71ff.).

One of the interesting aspects of the bill is its list of impediments to full use of telecommunications technology. As abbreviated in Ref. 35, pg. 73, these include:

- "lack of adequate information about or understanding of telecommunications technology among a significant number of those in a position to hasten, deter, or regulate its progress;

- lack of sufficiently detailed social, economic, and technical information to enable sound selection from among the many choices and options offered by telecommunications technology;

- lack of national goals, priorities, policies, and plans specific to telecommunications;

- lack of sufficient engineering and commercial standardization for telecommunications; and

- lack of sufficient capital to finance production of telecommunications technology products and services which have not yet been demonstrated to be marketable."

Report titled: A Preliminary Review of Current Practices and Trends In Rural Telecommunications Development And Recommendations For Future Development

This recent report was prepared by the Booker T. Washington Foundation/ Cablecommunications Resource Center (CRC) for the Department of Commerce. To our knowledge, it is the only recent detailed study of the potential for, and problems associated with, bringing telecommunications to rural areas.

Some of the findings of the CRC study parallel those of this study. The first five are as follows (35-90ff.):

> "1. There has been a significant number of projects designed to test the applicability of telecommunications technology to various aspects of community development. The majority of these demonstrations have centered on the delivery of health and educational services. While most of these experiments can be termed "successful" in improving the ability of telecommunications technology to deliver those services effectively, few, if any, of the projects have focused specifically on their application to rural areas of the country. It is generally acknowledged that the delivery of community development services to rural areas poses particular sets of problems that have not been addressed by most telecommunications demonstration projects.
>
> 2. Several service areas falling under the general categories of social services (i.e., employment, economic/financial, political, etc.) and entertainment/recreation/cultural services have not been the subjects of significant demonstration programs in spite of: a) their recognized role in determining the quality of rural living conditions; b) the unique ability of telecommunications technologies to serve these areas; and c) the understood potential of these services (particularly entertainment) to play an important part in improved community economic development.
>
> 3. Most demonstrations have been carefully structured to prove the capability of telecommunications hardware. The extremely important area of cost benefits resulting from hardware installation and software program implementation has been largely unexplored on any substantive level. The economic analysis section of this study defined a major problem blocking the further development of effective cost benefit analysis as being the lack of social accounting system or measurement indicators incorporating quality of life factors.
>
> 4. The development and implementation of telecommunications technologies for overall community development as it applies to rural areas must be considered and evaluated on regional bases if the effect of these programs is to be maximized. Programs developed and coordinated on a regional level ultimately can have more impact both economically and socially for regional consideration and will impart economies of scale to major demonstration programs which, in turn, will work to defray the capital costs of both hardware and software.

> 5. A significant number of demonstration programs to date have neglected the importance of software programming. It is essential to conduct research and demonstrations that specifically address software production based on articulated needs, systematized needs assessments, impact measurement, and evaluation of the development process. The production of effective software is vital to any meaningful assessment of telecommunications to meet rural economic development needs, both technologically and economically."

However, the findings of this OTA staff study differ from those articulated in the Cablecommunications Resource Center (CRC) report in several ways. Noteworthy among these are:

- the CRC Report recommends establishing low interest loans for building rural telecommunications systems (35-95). As discussed earlier, a large-scale low interest loan program seems premature at the present time. Instead, the present state of knowledge suggests the need for an intermediate step -- system demonstrations.

- the CRC Report supports low interest loans but does not consider other mechanisms. By contrast, this study has proposed that if system demonstrations show the feasibility and value of rural telecommunications systems, then different funding mechanisms may be appropriate depending upon the economic characteristics of each rural area. A useful gross classification which may indicate which funding mechanism might be appropriate is that of Turnaround Acceleration, Turnaround Reversal and Declining counties. Loan guarantees, low-cost loans or outright grants might be used to fund telecommunications systems depending on the economic strength of the community.

- the concept of public services "paying their own way" and making possible reduced costs for individual subscribers receives considerable attention in this study but not in the CRC report.

- commercial users of rural telecommunications systems (e.g., banks) are considered important sources of revenue in this report.

In summary, if the CRC report and this study are compared, it might be said that this study both goes beyond, as well as steps backward, from the CRC report. The system approach builds upon the kind of findings presented in the CRC report. The need for an interim system demonstration phase before funds are made available for widespread implementation of rural telecommunications, on the other hand, might be interpreted as a step backwards from the conclusions reached by CRC.

Summary

A number of bills and studies have been discussed. These may be divided into three groups depending on their treatment of the problem of bringing broadband communications to rural areas.

The Whitehead Report exemplifies the class of national cable policy studies. Within this class of studies, rural cable is treated more as a monitoring problem than as a problem requiring action. Thus, it is not surprising that no specific course of action is outlined nor is a funding mechanism proposed for bringing cable to rural areas.

The second group of bills and studies includes S. 1219, H.R. 5319, H.R. 244 (38, 39, 40), the Interstate and Foreign Commerce Subcommittee report on cable (27) and the Booker T. Washington/Cablecommunications Resource Center report on rural telecommunications (35). This group suggests that telecommunications should be brought to rural areas now and suggests low-cost long-term loans as the funding mechanism. The implication is that the major constraint on rural telecommunications is lack of risk captial.

The third group of bills includes H.R. 4564, S. 1257 and H.R. 9630 (41, 42, 43, 44). This group specifically addresses the problem of providing new services, such as public service applications, via telecommunications and proposes demonstration programs which would enable evaluation of such services. Unlike the second group, these bills are _not_ directed at rural areas and probably projects would not take place in rural areas. This is because the funds, when specified, are to be used for studying _methods_ for bringing in the service. Existing systems would be used in the demonstrations and those with significant capacity -- as for two-way use -- are located in metro areas.

This report combines and extends the concepts in all these groups of bills and studies. It proposes a limited demonstration program, specifically for rural areas, aimed at investigating the feasibility and value of combinations of public services, commercial uses and entertainment. The concept of area-wide coverage and accessibility to the system by residents of the most remote areas, as well as in the most densely populated areas within a community, is emphasized. The program might be administered by NSF in conjunction with the Departments of Commerce and Agriculture. If the feasibility and value of the system concept were then demonstrated, different funding mechanisms might be matched to the economic characteristics of different rural communities.

Policy Alternatives For Applications Of Broadband Telecommunications To Rural Areas

Three policy alternatives are presented in the following discussion. The pros and cons of each of these alternatives are briefly considered. These policy alternatives are:

- continue the status quo;
- fund a limited number of system demonstrations projects; and
- create a Federal mechanism to facilitate wide dissemination of broadband services in rural areas.

Continue Status Quo

The term "status quo" does not imply that Federal programs are presently having no effect upon the development of rural broadband systems; rather, it refers to the continuance of a particular set of Federal policies that have not had the effect of promoting their widespread deployment at this time. On the one hand, the Federal government has funded research into the uses of broadband in both urban and rural areas. On the other, with the exception of the isolated instance in which the Farmers Home Administration granted a loan to Trempealeau County, no Federal program presently exists which can be of direct assistance in helping rural areas to translate these potential broadband uses into actual system applications.

"Status quo" as a Federal policy alternative is therefore defined as continued Federal support for research into the general uses of broadband communications, but relatively little emphasis on programs designed to assist in their actual deployment in rural systems. The key issue to be addressed in considering this policy alternative is whether it is desirable or necessary that the Federal government make an increased effort to encourage and assist such deployment.

Pro. If telecommunications represents 'the wave of the future' and if it is likely, as some contend, to transform the way in which we live and work, then it is reasonable to assume that it will someday come to rural America, first to those rural areas adjacent to metropolitan areas and, subsequently, through the use of fiber optics or similar cost-cutting breakthroughs, to more remote rural areas. In other words, under these assumptions, telecommunications will eventually come to rural areas without specific Federal assistance.

In the meantime, Federal programs are already in existence that might provide more data on the value of new broadband services. The NSF Phase II experiments, in particular, could demonstrate the general value of these services and may also interest system operators in the revenue-generating potential of public service applications -- provided that communities also perceive their value and are willing to expend funds for their use of the system. Continuation of the "status quo" might also prevent rushing into widespread rural applications of broadband communications before their value -- and economic feasibility -- are demonstrated.

Con. To the extent that the pace and nature of rural development remain a primary concern of the Federal government, it would seem inconsistent that the introduction of broadband systems be left to proceed on a "catch-as-catch-can" basis. While the value and feasibility of many broadband services have yet to be conclusively demonstrated, their potential in contributing to the objectives of rural development, as outlined in Chapter III, would seem too great for their implementation to be ignored. Although the introduction of broadband systems into rural areas eventually might occur unassisted, it could well bypass those rural areas most in need of the benefits the systems could bring and, to the extent that introduction is delayed longer than need be, unnecessarily prolong their lack of access. At minimum, it would seem consistent with other Federal efforts in the area of rural development that this possible instrument of change be given a fair opportunity to prove itself in actual system applications.

As to the need for assistance if such systems are to be deployed in any significant number, there does not seem much question. At best, the novelty and untested economics of the services to be provided, including their unknown costs and benefits as compared to alternative ways of providing the same services, are likely to make financing difficult for even the most carefully planned systems. If the multitude of tasks involved in surveying community needs, designing revenue-producing broadband programs to service these needs, securing community and local government support, estimating hardware needs and costs, and so on are added to these unknowns, then the practical barriers for most potential system operators are likely to be insurmountable.

Additionally, to the extent that the interests and needs of rural systems are not of major concern when decisions are made at the Federal level concerning communications policy, then the future development of such systems could be effectively foreclosed. To give only a few examples, on the assumption that cable systems are not feasible in very low density areas, a decision could be made to promote translator coverage of rural America, with cable being limited to more densely populated rural towns. This "skimming of the cream" by conventional cable systems and the relegation of rural areas unprofitable for cable-like, two-way systems to coverage by translators, could prematurely eliminate one of the main bases of support for full-service, area-coverage systems. Alternatively, with the advent of fiber optics, a decision might be made to assign their exclusive use to a national communications network without taking into consideration their possible use in individual rural-based systems.

Fund A Limited Number of System Demonstration Projects

This alternative has been thoroughly discussed in previous sections of this Chapter. It has been suggested that a minimum of two demonstration projects for each of two of the three types of rural counties (Turnaround Acceleration, Turnaround Reversal) be initiated.

Pro. Current data are inadequate to evaluate the utility of broadband communications to rural areas. It is likely that the cost-effectiveness of broadband will vary with the characteristics of rural communities receiving the services. However, hard data on this point do not exist.

Simply making channels available for public service and institutional use of broadband communications will not guarantee that effective use will be made of them. The message rather than the medium is the economic commodity in a broadband system. A system demonstration program will help develop hard data on the uses to which these systems can be put.

It appears that some types of broadband services in rural areas could be attractive to potential operators. However, the components of an effective systems package are not known.

Cable operators to date have seen little profit in channels dedicated to public service and institutional use. If system demonstrations show the economic value of such channels and indicate the fair price for these uses, these attitudes might change. Additionally, a new class of broadband operators, capable of putting together packages of services, could develop. However, such development requires time -- and demonstration.

This practical emphasis upon real-world applications could have a beneficial effect upon the rest of the Federal Government's considerable investment in broadband research. Experiments could be designed with their eventual application in actual demonstrations in mind, and in turn the results of demonstrations could be used in determining the further need for experimentation.

A system demonstration program will enable the Federal Government to evaluate whether broadband services to rural areas are economically feasible -- before large sums of money are committed to such efforts.

Con. System demonstrations could be opposed on the grounds that the consequences of providing health, education, and other services "by remote control" are not sufficiently understood. This is an important issue and will be taken up in connection with the next policy alternative. For now, it is sufficient to note that the system demonstrations here contemplated would be fixed both in time and number. If these innovative services prove to be detrimental, it will be a relatively simple matter to terminate them.

It also can be argued that demonstrations should not proceed until there has been settlement of the broader issue of Federal policy toward cable television generally. Even though the special requirements and functions of rural systems seem not to have entered into the present debate over FCC regulations, a decision at this time to authorize demonstrations could be criticized as a "backdoor" attempt to skirt the issue in favor of the interests of these systems.

A system demonstration program might take as long as five years. If system demonstrations are not really needed, services to the rural populations not served by the demonstrations will have been unnecessarily delayed.

Create A Federal Mechanism To Facilitate Wide Dissemination Of Broadband Services in Rural Areas

The legislative approach most often suggested (e.g., see references 5 and 27) consists of low-cost, long-term loans paralleling those made available under the Rural Electrification Act of 1934. It is argued that the hesitancy of private industry to enter the rural market with broadband communications today is similar to the hesitancy of private industry forty years ago to enter the rural market with telephones and electric service. Thus, the mechanism which was effective then (largely because of the rural cooperatives) should be effective now.

Pro. Implementation of broadband communications in rural areas could begin as soon as legislation for an appropriate Federal mechanism was passed by the Congress.

If the parallel between broadband services and electricity/telephone service is valid, further delay is unnecessary.

The Rural Electrification Act of 1934 created a relatively inexpensive Federal program. Government expense consists of debt service on the loans plus the cost of administering the program.

Con. The parallel with the Rural Electrification Act of 1934 may not be valid. Effective use of broadband communications for education, health, and commerical use requires development of program content and/or computer software. Simply helping an operator to secure funding for a system might not be enough to enable the system to have a fair chance of success.

Without specific encouragement to the contrary, the probable use of new systems is likely to be limited to conventional news and entertainment television. Development of unique services specifically tailored to rural needs would probably not occur because they would have no demonstrated value and thus significant fees for these services could not be justified. Without the economic base such services could provide, higher fees would have to be charged individual subscribers to support the system, thus restricting access to the more affluent members of the community. The result might be a system providing limited service to a limited number of viewers.

A fundamental objection that could be raised to this policy alternative as well as to any effort to promote the innovative public service use of broadband, is that fascination with gadgetry and a desire to seem up to date might lead communities to an uncritical acceptance of "standard" broadband solutions to the problems of improving education and health care. Even though these broadband services might have been tested in demonstrations they still could turn out to be inappropriate when applied against the needs of the full range of all rural areas. If precautions are not taken to avoid the latter contingency and if the quality of educational and health care deteriorates, the rural area in question still might remain locked into delivery mechanisms in which all but the consumers had a vested and continuing interest.

Future OTA Role

As stated in the Preface, the object of this staff study was to provide a basis upon which the Technology Assessment Board might decide what contribution, if any, OTA might make in assisting the Senate Committee on Agriculture and Forestry to evaluate the feasibility and value of rural broadband communications.

In the course of the staff study, the subject of rural broadband communications was found to be relatively unexplored. In particular, no analyses were found which considered the utility of broadband in relation to the fundamental factors underlying the sudden reversal of growth trends in rural America depicted in most recent Census statistics. Therefore, in order to gain some clear understanding of what OTA might do in connection with the subject, it first was necessary to originate a conceptual means of relating broadband to the forces underlying this change. Subsequently, it was necessary to consider how and whether such systems could actually be deployed and their value assessed.

Because of these somewhat unique circumstances, this study does not constitute a simple reply to Senator Talmadge's query as to how OTA can be of assistance. Instead, what is reflected in this staff study is a possible course of action the Senate Agriculture Committee might weigh. OTA's future role and the specific form its assistance might take, therefore, will depend upon the Committee's judgment as to which of the courses of action spelled out herein, if any, it might wish to explore further.

With these qualifications in mind, the following is a three-part approach to OTA's participation that the Senate Committee might consider:

First as an adjunct to hearings the Committee might wish to conduct, OTA could help the Committee to assemble a panel(s) to examine and verify or refute the findings described in this report. Topics to be covered could include:

- the present and probable future trends in rural growth;
- the impact of broadband communications on probable growth trends;
- constraints to wider application of broadband communications in rural areas;
- the need for system demonstrations and the number and type of system demonstrations which should be conducted, including criteria for site selection;
- consideration of the possible need for, and best form of, Federal involvement in rural broadband applications in the system demonstration phase as well as in subsequent programs; and

- consideration of the possible role of OTA in helping the Committee to assess and monitor the programs suggested above.

Second, OTA might begin a continuing assessment program to help the committee monitor: 1) telecommunications experiments in or applicable to rural areas; and, 2) the progress of the Trempealeau County project and any system demonstrations undertaken. With regard to the second task, a critical feature would be assessing the impact of telecommunications on the characteristics of life in rural areas affected. (Assessing whether these impacts might be desirable is outside the scope of OTA activities. The purpose of this monitoring effort would be to provide the committee with data from which a judgment could be made.)

Third, on an as-needed basis, small assessments involving either panels or other mechanisms could be conducted to integrate the data of the monitoring efforts with other data, including the preliminary findings of this study.

Because any system demonstration will require several years, what is proposed here is a long-term relatively low-cost activity. An estimated level of effort and cost is as follows:

- 1/2 manyear/year of senior staff =$17,000
- 1/2 manyear/year of support staff = 9,000
- 1/3 manyear/year of secretarial support = 5,000
- average yearly cost of panels, small contracts, etc. = 30,000
- contingencies including staff travel = 4,000

$65,000/year

It is anticipated that OTA's participation in the project would be reviewed by the Technology Assessment Board at least biyearly. At these times, both the progress and the adequacy of OTA's effort would be subjects of evaluation.

CHAPTER IV

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APPENDICES

APPENDIX A

REQUESTING LETTER FROM SENATOR TALMADGE

HERMAN E. TALMADGE, GA., CHAIRMAN

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COTYS M. MOUSER, CHIEF CLERK

United States Senate
COMMITTEE ON
AGRICULTURE AND FORESTRY
WASHINGTON, D.C. 20510

June 25, 1974

Emilio Q. Daddario
Director
Office of Technology Assessment
300 New Jersey Avenue, S.E.
Washington, D. C. 20515

Dear Mr. Director:

For all of my career, I have been seriously concerned about the problem of equity for rural people. I have had some successes and some failures in dealing with this problem, but the fact remains that it is very difficult to deliver basic human services to people who live in low density circumstances in the American countryside.

Therefore, I was very excited to receive the enclosed good letter from Russell A. O'Neal, General Manager of the Wisconsin Electric Cooperative Association concerning the use of broad-band two-way telecommunications in rural areas. As you will see from Mr. Kaye's enclosed paper on transportation of older Americans in rural areas, he suggests that some transportation of people in rural areas might be supplanted with just such a system.

I am also enclosing a copy of Rural Electric magazine which describes some of the activities which rural electric cooperatives are doing in regard to cable television, as well as the New Rural Society Project of Dr. Peter Goldmark. This material is on pages 12-20.

I also call your attention to a communications satellite which was launched recently that will be used to train rural para-professionals in Appalachia and the Rocky Mountain States, and then will be turned around to beam a signal to India. From what I have seen of this project, it was hastily conceived and launched before there was a clear understanding by anyone of what was to be accomplished. However, it is an example of the fact that communications can play an important role in reaching rural people, providing some types of services, educating and informing.

I am aware that the FCC is still groping with the notion of what it wants cable television to be, and this indecision has caused delays in exploring the full potential of the concept of a "wired nation".

But it seems to me that we already are a wired nation. It is my understanding that with some modifications, lines which carry electricity can also carry television pictures. Therefore, it would appear that the rural electric systems which are already in place in rural areas could provide a vital new service for rural people at a limited cost.

However, it is not the intention of the rural electrics to capture all of cable television in rural areas. Many and perhaps most of these cooperatives may not want to get involved at all.

But for those which might want to get involved -- for that matter, for any individual or group which might want to get involved, the potential for using communications technology as one of the components that make up the concept of broad based rural community development is a new ballgame.

Therefore, I would appreciate it if OTA would consider a project to determine the feasibility and value of experimental efforts to develop public service for rural areas through the use of broadband communications techniques, whether cable or satellite.

If it would be helpful to your staff in determining whether to attempt this project, I would be pleased to put them in touch with Mr. Kaye, Dr. Goldmark and the National Rural Electric Cooperative Association.

With every good wish, I am,

Sincerely,

Herman E Talmadge

HERMAN E. TALMADGE
Chairman

cc: Ira Kaye
Russell A. O'Neal
Dr. Peter Goldmark
Tom Hoy
Robert Partridge
David Hamil

APPENDIX B

PERSONS INTERVIEWED

Gary Alpert, ADT Security Systems, Denver Colorado

A. J. Anderson, Communications Department, State of Colorado, Denver, Colorado

Frank Ashford, Darco Telemetering Systems, Omaha, Nebraska

William Barnhart, Cadco, Inc., Garland, Texas

John R. Barrington, Home Box Office, Inc., (Time Corp.), New York, New York

George Bartlett, National Association of Broadcasters, Washington, D.C.

Rashid Bashshur, Department of Medical Care Organization, University of Michigan, Ann Arbor, Michigan

Judith Bazemore, The Rand Corporation, Spartanburg, South Carolina

Calvin Beale, Economic Research Service, U.S. Department of Agriculture, Washington, D.C.

Layne Beaty, Office of Communications, U.S. Department of Agriculture, Washington, D.C.

Brian Belcher, TOCOM, Inc., Irving, Texas

Blair Benson, Goldmark Communications Corp., Stamford, Connecticut

Michael Blair, Reuters, Ltd., New York, New York

Issac Blonder, Blonder-Tongue Laboratories, Inc., Old Bridge, New Jersey

John Bowles, Community Facilities Division, Farmers Home Administration, U.S. Department of Agriculture, Washington, D.C.

Charles Brady, Indian Health Service, U.S. Department of Health, Education and Welfare, Washington, D.C.

Brian Brock, Darco Telemetering Systems, Omaha, Nebraska

Charles Brownstein, National Science Foundation, Washington, D.C.

Robert Burgers, Northwest Computer Services, Minneapolis, Minnesota

William Burns, First National Bank of Lafayette, Lafayette, Colorado

Edward Callahan, American Television and Communications Corporation, Denver, Colorado

Lita Colligan, Rehabilitation Services Administration, U.S. Department of Health, Education and Welfare, Washington, D.C.

William Clements, Mountain Bell Telephone Company, Denver, Colorado

Howard Crispin, Scientific - Atlanta, Inc., Atlanta, Georgia

Larry A. Day, Continental Telephone Service Corporation, Bakersfield, California

Robert V. C. Dickinson, E/Com Corporation, Berkley Heights, New Jersey

David Dixon, Rural Health Associates, Farmington, Maine

Floyd English, Darco Telemetering Systems, Omaha, Nebraska

Ann Erdman, Office of Telecommunications Policy, Department of Health, Education and Welfare, Washington, D. C.

Donald Flansburg, Mountain Bell Telephone Company, Denver, Colorado

Dennis Goldstein, Appalachian Regional Commission, Washington, D. C.

Paul Guthrie, Executive Services Division, Department of Administration, State of Wisconsin, Madison, Wisconsin

Marvin Halton, AT&T, Washington, D. C.

Samuel Hardin, Farmers Home Administration, Stevens Point, Wisconsin

Samuel B. Harvey, Singer Corporation, New York, New York

Jocelle Heatherly, Spartanburg Technical College, Spartanburg, South Carolina

Gordon Herring, TeleCable Corporation, Norfolk, Virginia

C. Palmer Hickey, Business and Industrial Loan Division, Farmers Home Administration, U. S. Department of Agriculture, Washington, D. C.

Carol Lee Hielwich, Goldmark Communications Corp., Stamford, Connecticut

Larry Higgins, United Bank of Denver, Denver, Colorado

Edward D. Horowitz, Home Box Office, Inc. (Time Corp.), New York, New York

Tom Hoy, Writer for the National Rural Electrical Cooperative Association, Washington, D. C.

Ira Kaye, Consultant to Congressional Rural Caucus, Washington, D.C.

Peg Kay, Consultant, Washington, D.C.

Joseph Kelly, Manhattan Cable (Time Corp.), New York, New York

Dennis Kirkman, Trempealeau Valley School Cooperative, Trempealeau, Wisconsin

Jans Kliphuis, Intech Laboratories, Inc., Roskoskoma, New York

Donald Knowlton, Colorado Cooperative Council, Denver, Colorado

Charles Lowe, TOCOM, Inc., Irving, Texas

William Lucas, The Rand Corporation, Spartanburg, South Carolina and Washington, D.C.

Capt. William McCaa, Boulder County Sheriffs Department, Boulder, Colorado

Sergeant Frank McCarron, Philadelphia Police Department, Philadelphia, Pennsylvania

Kenneth W. McCharen, Tulsa Public Schools, Tulsa, Oklahoma

Alan Maltz, Bankers Trust Company, New York, New York

Dr. Roger Mark, Boston City Hospital, Boston, Massachusetts

Raymond J. Marks, Public Service Company of Colorado, Denver, Colorado

Gordon Meistad, Trempealeau Electric Cooperative, Trempealeau, Wisconsin

S. Byers Miller, Bank Administration Institute, Park Ridge, Illinois

William Moore, Union Trust Company, Stamford, Connecticut

Tom Mulherin, INTERACT, Dartmouth - Hitchcock Medical Center, Hanover, New Hampshire

Victor Nicholson, Cable Television Information Center, Washington, D. C.

Gerhard Nilsestuen, Trempealeau County Association of Cooperatives, Trempealeau, Wisconsin

Donald Norman, Farmers Home Administration, Williamston, North Carolina

Gary Nugent, Extension Service, U. S. Department of Agriculture, Washington, D. C.

Dr. Jack O'Neill, Mitre Corporation, McLean, Virginia

Robert Ottman, Western Telecommunications, Inc., (WIIC), Denver, Colorado

Joseph Paglia, Philadelphia Police Department, Philadelphia, Pennsylvania

Ben Park, Alternate Media Center, New York University, New York

Ms. Jacqueline Park, Alternate Media Center, New York University, New York

Delmer C. Ports, National Cable Television Association, Washington, D.C.

Robert Powers, F.C.C. Cable Bureau, Washington, D.C.

Lt. Charles Pringle, Boulder County Sheriffs Department, Boulder, Colorado

James Rathbun, Farmland Industries, Inc., Kansas City, Missouri

Maurice Rhodes, Blue Ridge Electric Membership Corporation, Lenoir, North Carolin

Steven Rivkin, Attorney at Law, Washington, D.C.

Maxine Rockoff, National Center for Health Services Research, Health Resources Administration, Rockville, Maryland

Solomon Sagall, Teleglobe Pay-TV Systems, Inc., New York, New York

Vincent Sardella, Office of Telecommunications Policy, Washington, D. C.

Dr. Louis Sasmor, Westinghouse Health Systems, Miami, Florida

James Schmeiser, Teleprompter, Inc., New York, New York

Robert Schneider, Farmers Home Administration, Stevens Point, Wisconsin

Robert Schuman, Appalachian Regional Commission, Washington, D. C.

Allen M. Shinn, Jr., National Science Foundation, Washington, D. C.

Donald A. Smith, INTERACT, Dartmouth-Hitchcock Medical Center, Hanover, New Hampshire

William Smith, Cadeo, Inc., Garland, Texas

Shelby Southard, Cooperative League of the U. S. A., Washington, D. C.

George Steffen, Bank Administration Institute, Park Ridge, Illinois

Bermey Stevens, Windsor CableVision, Williamston, North Carolina

James Stevens, Public Service Company of Colorado, Denver, Colorado

William Tadlock III, Farmers Home Administration, Williamston, North Carolina

Rod Thomas, First National Bank of Denver, Denver, Colorado

Ernest Unrein, Farmers Marketing Association, Denver, Colorado

William Urban, Trempealeau Valley School Cooperative, Trempealeau, Wisconsin

Joseph Wager, Peoples National Gas Company, Omaha, Nebraska

Russell White, Public Service Company of Colorado, Denver, Colorado

Shirley White, Cornell University, Ithaca, New York

Thelma Whitesill, Farmland Industries, Inc., Denver, Colorado

David Willis, Tele-Communications, Inc., Denver, Colorado

Ed Wilson, Bureau of Education for the Handicapped, Department of Health, Education and Welfare, Washington, D.C.

James Wright, Rockford Cablevision, Rockford, Illinois

Harry Zacher, Philadelphia Police Department, Philadelphia, Pennsylvania

APPENDIX C

HEALTH NEEDS IN RURAL POPULATIONS

The purpose of this Appendix is to examine the health services and needs of rural populations. Analysis of the health care needs of rural areas is difficult because of the lack of homogeneity among rural populations. Differences in economics, occupations, and population density and dispersal among rural areas limits the conclusions which can be drawn. Nevertheless, on an aggregate basis there are some significant general differences between health in rural and urban areas.

Available data on health characteristics suggest a number of important needs in rural areas including:

- need for increased primary health, medical specialist, and dental care;
- need for greater accessibility to medical facilities and services;
- need for increased emergency medical services; and
- need for continuing medical education for physicians, specialists, and other allied health manpower.

In the following pages, the various health conditions, resources, and services of rural areas are discussed. The factors and reasons for the existence of these health care needs are examined, and recent federal initiatives related to rural health services are highlighted.

Health Conditions in Rural Areas

Health conditions in rural areas can be identified from the rates of chronic diseases, mortality, and injury among rural populations. Comparisons are made with metropolitan rates to illustrate the differences of health conditions in rural populations.

Chronic medical conditions such as heart disease, diabetes and asthma are more prevalent in persons between the ages of 17 and 64 living outside metropolitan areas than in persons living in metropolitan areas. There is an even more dramatic difference in chronic illness for persons 65 and over. Approximately 50 percent of farm persons and 47 percent of non-farm persons over 65 from nonmetropolitan areas suffer from limitation of activity due to chronic illness compared to 39 percent of persons of similar age living in metropolitan areas (1-18). Several reasons which may account for this are the lack of availability of medical care to permit early detection of such conditions, lack of knowledge on the part of populations about the necessity for diagnosis and medical treatment and the distances which must be travelled to obtain medical care. Money necessary to pay for medication and medical service and sociological reasons, such as fear of separation from family, may also inhibit persons from obtaining medical treatment.

Two factors demonstrating health conditions are the rates of infant and maternal mortality. The data show that infant and maternal mortality rates are higher in nonmetropolitan areas than in metropolitan areas. There are 23.0 infant deaths per 1,000 live births in nonmetro areas compared to 21.1 in metro areas. There are 26.4 maternal deaths per 100,000 live births compared to 23.6 for metro areas (1-16). There is no definitive explanation for this difference, however more deliveries are likely to occur in a nonmedical environment in rural areas due to the distances that must be travelled to receive medical assistance. This factor introduces a greater element of risk, particularly in complicated deliveries. In addition, lack of medical specialists for prenatal care in nonmetro areas may contribute to the higher incidence of infant and maternal mortality in those areas.

An unpublished HEW report showed that rural nonfarm residents had a higher injury rate than did either rural farm residents or metropolitan residents. Persons injured were defined as those needing medical attention or limited in activity for at least one day. In metropolitan areas approximately 247 persons per 1,000 were injured annually compared to 256 rural nonfarm persons per 1,000 and 225 rural farm persons per 1,000 (1-18ff.). The reasons for the higher injury rate among nonfarm rural people are unknown although some hazardous occupations such as mining are found in nonfarm rural areas. However, it appears unusual that farm residents showed the lowest injury rate considering the type of work they do. Farm work, the distance which must be travelled to obtain assistance, and the condition of the roads may result in a lowering of the reporting rate and therefore result in a statistically lower injury rate. According to an article published in Rural and Appalachian Health, "the West Virginia State Road Commission reported that in 1965 within an eight-county area only one-fifth of the road mileage met minimum specifications" (2-41).

Another factor indicating health conditions of rural populations is the rejection rate of persons for military service. Statistical evidence provided by USDA shows that rural residents between the ages of 27 and 34 had a rejection rate for the military service for physical and mental health conditions at least twice as high as those from metropolitan areas and residents from small cities and towns of 25,000 (1-18). This provides another indication of the health conditions of rural populations.

Health Resources of Rural Areas

Health resources in rural areas include health facilities, manpower, and emergency medical services. The degree of accessibility of those resources to rural residents is also important.

Health manpower is traditionally concentrated in areas with greater concentrations of people (1-1). Rural populations have less than half as many doctors per capita as do urban areas. Of the doctors serving rural areas there are proportionately more general practitioners than there are specialists. In contrast, metropolitan areas have a greater number of specialists than general practitioners. According to the USDA report, in 1970 there were 16,457 general practitioners, 16,377 specialists, and 4,507 hospital-based, nonfederal physicians serving nonmetropolitan areas. There were 34,359 general practitioners, 121,731 specialists, and 61,596 hospital-based physicians serving metropolitan areas. The ratio of physicians per 100,000 population for nonmetropolitan areas was 30.4 for general practitioners, 30.3 for specialists, and 8.3 for hospital-based physicians. The ratio of physicians per 100,000 for metropolitan areas was 23.0 for general practitioners, 81.5 for specialists, and 41.2 for hospital-based physicians (1-7ff.). There are proportionately fewer dentists, pharmacists, and registered nurses serving rural areas compared to those serving urban areas. In 1966 and 1967, there were 54.7 pharmacists per 100,000 in metropolitan areas compared to 43.7 for nonmetropolitan areas; 332.1

registered nurses per 100,000 for metro areas compared to 223.0 for nonmetro areas; and 61.7 dentists per 100,000 for metro areas compared to 35.5 for nonmetro areas (1-9ff.).

A variety of reasons can be advanced to account for the phenomenon of a shortage and maldistribution of health manpower. In the case of physicians, there is evidence indicating that a rural background is a strong contributing factor in a physician's choice of a rural practice. Almost half of the physicians practicing in towns of 2,500 or less are from communities of similar size (3-11ff.). Cooper states that "practice in a small community is more likely to be the choice of those who grew up in small communities than of those who did not" (4-940). In addition, factors of location of the medical school attended by the physician and the location of the internship and residency also tend to influence the choice of location or practice. According to an article published in the Journal of Medical Education:

> "Current medical education is not, for the most part, designed to train and encourage rural practitioners. Though there are welcome signs of change, medical students still receive most of their training in institutions which are oriented toward special practice and secondary and tertiary care of inpatients. Since students receive very little exposure to family practice in general, it is unrealistic to expect them to enter rural practice" (5-886).

Other reasons for the maldistribution of physicians and shortage of physicians in rural areas arise from some of the unique features of a rural practice for both the general practitioner and the specialists. In general, the rural physician is characterized as a person who is isolated from peer consultations and referrals. He or she is isolated from easily accessible information regarding new medical trends and procedures. The rural practitioner may have difficulty locating his or her practice close to facilities which may be equipped with the latest medical instruments and technology. And, too, the rural physician is in a position which requires service to a greater number of people distributed over a larger land area. The generalist physician in a rural practice is confronted with cases requiring specialist attention. Yet the resources are often not available to the physician to effectively refer and assist patients in such situations. The specialist in rural practice finds that in order to make the practice ecnomically feasible, a large portion of time must be spent on generalist cases thereby diminishing the prospects of furthering his or her development in the work for which training was received (10-55). Phillips and his colleagues have noted in a study that:

> "The social and economic nature of rural areas repel most young physicians, even those considering solo practice, as well as their families. None (of the physicians contacted) were particularly enchanted with the low economy, the poor school systems, sparse population, the paucity of cultural opportunities, the isolation from modern medical facilities and the round the clock practice, especially when these were compared with the advantages of urban life. Even the energetic outdoors man or the disenchanted city dweller seeking the bucolic country life found the small country community cramped, limited and confining" (6-1263ff.).

Another contributing factor to the shortage of physicians in rural areas is the increasing median age of rural doctors and the difficulties communities have in replacing physicians who leave, retire or die. A study of 20 rural counties in Missouri showed that between 1958 and 1973 there was a 33 percent attrition rate of MDs serving those areas. In 1958, there were 100 practicing physicians. The greatest losses were due to death and migration but retirement was also a factor. For the period between 1965 and 1973 the counties lost 22 MDs. Of those lost, ten moved, nine died and three retired (7-313ff.). Taylor and his colleagues have indicated that

"Whether caused by a national shortage of physicians, or by maldistribution, or both, younger physicians are failing to replace established practitioners who leave rural practices due to death, retirement, or overwork" (5-885).

Reasons for the disproportionate distribution of dentists, and other categories of health manpower may also be attributed to factors similar to those for physicians. For dentists, metropolitan areas are more appealing due to the larger number of persons to be served per unit area and the greater access to the equipment, facilities and support staff necessary for a practice. In the case of nurses and pharmacists, these fields have been linked traditionally to primary health service facilities and manpower in the role of support staff. As such, choice of location in a rural area would seem less likely for those in the field. Concurrently, the economic advantages, advancement possibilities and continuing education incentives for those in nursing and pharmacy are greater in the more densely populated areas.

Another factor related to health resources for rural populations is the availability of health facilities. Statistics show that there are proportionately more hospital beds per capita for rural areas than for metropolitan areas. The USDA report states that there were 7,123 hospitals in the U.S. in 1970. Of that number, 82% or approximately 5,800 were community hospitals. Overall, there were 977.3 hospital beds per 100,000 in rural areas compared to 719.2 beds for urban areas. Further analysis of hospital facilities in metro and nonmetro areas showed that nonmetro areas had both proportionately more long term hospital beds for psychiatric care and more community hospital beds for short term care than did metro areas. There were 370.6 psychiatric beds per 100,000 in nonmetro areas compared to 207.2 psychiatric beds in metro areas. There were 497.6 community hospital beds per 100,000 for nonmetro areas compared to 394.1 for metro areas (1-12ff).

These facts present an interesting disparity in the distribution of physical and mental health facilities among metro and nonmetro areas. In the categories of hospitals, rural areas have relatively more facilities. The reasons for the existence of more hospitals can partially be explained by the federal monies provided for construction of medical facilities in the Hill-Burton Act based in part on the philosophy that the introduction of facilities to underserved areas would attract more health manpower to those areas. This hypothesis was essentially disproved by the programs which built a number of community health clinics or hospitals for the purpose of attracting health manpower and increasing health services to certain rural areas. Communities continued to experience difficulty in attracting and keeping physicians and other allied health manpower despite the new buildings and equipment (2-38ff.).

The reasons for the disparity in mental health facilities between metro and nonmetro areas are unclear. However, traditionally state and private mental institutions have been placed away from large concentrations of people, and hence have been located in rural areas. Another pertinent and unanswered question related to the location of mental health facilities is: are the patients in these rural institutions from rural or from urban areas?

The correlation of inadequate manpower, distribution of facilities, and the extent to which the facilities can be furnished with modern equipment directly affects the quality of health resources for rural populations. It appears that the existence of a greater proportion of hospital facilities in rural areas does not necessarily compensate for the health problems which rural people face.

Accessibility of health resources is a key aspect of health care for rural populations. One type of accessibility is physical and is related to the distances which people must travel to health resources and the transportation systems available to them. Despite the fact that there are more hospital beds for rural populations, rural people must still travel considerably more distance to receive health care or emergency medical services. Statements made in Rural and Appalachian Health give a revealing picture of rural Appalachian health manpower and facilities problems.

> ..."In a county where about half of the families earn less than $3,000 annually and the proportion of welfare cases is higher than the state norm, travel is too expensive for the majority. The county desperately needs transportation to out-of-county hospitals, as well as local emergency care and local practitioners... There are many such areas in the Appalachian region... where because of a lack of personal resources, inadequate public support of essential services, and unavailability of health care, significant proportions of the population have gone without any expert crisis medical care for many years. In these areas Hill-Burton built hospitals are understaffed and underused. In some of these hospitals entire wings are closed due to a shortage of physicians and nurses" (2-38ff.).

Rural persons not living in close access to health facilities or service areas have more difficulty obtaining primary health care or emergency medical service. Because the most common mode of transportation for people in rural areas is the automobile, those persons who do not have access to a car can have great difficulty in obtaining medical assistance. In addition, the roads and highway systems in some rural areas are at times impassable, making routine and emergency health care impossible. In addition to Appalachian areas these problems are also readily apparent in the northern regions of this country in areas such as Alaska, Maine and the Northern mid-west states.

The other type of accessibility is financial and is related to the costs of health care and provisions to pay for it. The cost of health care for many rural people is a limiting factor in terms of health resources accessibility. The economic characteristics of rural areas show that 14 percent of rural people are below the poverty level compared to 9.7 percent of metropolitan populations (8-16). In addition, the non-poverty level incomes are also lower in rural areas. Concurrently, statistics show that rural residents have a lower rate of hospital and surgical insurance than do urban residents. The percentage of metropolitan residents not covered with hospital insurance was 17.5 compared to 24.2 for rural nonfarm residents and 36.8 for rural farm residents. The percentage of metropolitan residents not covered with surgical insurance was 18.9 compared to 25.5 for rural nonfarm residents and 38.8 rural farm residents (1-23).

The reasons for the greater insurance coverage of metropolitan residents may be explained largely by the group insurance available through company employment plans. Another reason for the difference may be a lack of knowledge on the part of rural residents about insurance coverage, and economic ability to pay for coverage -- particularly in the group just above the poverty level.

One final health resource which should be examined for rural areas is the availability of emergency medical services. A great portion of the grants made possible by the Emergency Medical Services Act have been directed toward nonmetropolitan areas. However, the implications for rural populations of transportation, distance to health facilities, and health manpower shortages, render a rather bleak picture for those who require emergency health care.

Utilization of Health Services in Rural Areas

The extent to which rural populations utilize the health resources available to them may be related to the health conditions of those populations.

Utilization can be determined by several factors such as frequency of visits to physicians and the rate of hospitalization for rural populations.

Generally rural nonfarm residents used physician and dental services with slightly less frequency than metro populations. However, rural farm residents showed a sharply lower frequency of physician visits. In addition, statistics show a dramatic difference in the number of visits to specialists by rural residents compared to urban residents (1-11). These differences in rural areas reflect the manpower shortage, a lack of knowledge of the available services, the lack of funds necessary to pay for health care, and transportation difficulties. The differences also suggest inadequate reporting may be one reason for the lower incidence figures.

The hospitalization rate of rural nonfram residents is higher than that of persons living in metropolitan areas. The rural farm rate is lower except for persons over 65. According to the USDA report for all age groups, approximately 93 persons per 1,000 in metro areas were hospitalized in 1968 compared with 103 per 1,000 from rural nonfarms and 88 per 1,000 from rural farms. For persons over 65, 143 per 1,000 from metro areas were hospitalized compared with 171 from rural nonfarms and 195 from rural farms (1-20).

One hypothesis which could be advanced from greater hospitalization rates among nonfarm rural residents may be attributed to the lack of enough physicians and the type of facilities which provide outpatient care. Another is that hospital costs have not risen so high as to force a change to outpatient treatment where possible. The high hospitalization rates of the elderly in rural farm and nonfarm environments may be attributed to the inadequacy of health services for those populations, the lack of physicians, the inability of familes to provide the type of care necessary for the elderly suffering from chronic or immediate illness, and the apparent lack of nursing homes and other alternative care facilities. In addition, the lack of earlier health care may contribute to greater hospitalization rates.

Federal Efforts Related to Health Care Delivery in Rural America

The federal efforts impacting rural health care have increased considerably over the last two decades. However, these initiatives have largely been directed toward the general population rather than rural populations. Governmental programs have addressed specific problems such as health care financing, organization, manpower education, research and development, or health services and quality of care. A few, however, have been directed toward a very specific population such as indians or migrant workers.

One new important effort being made at the Federal level is the Rural Health Initiative being conducted by the Public Health Service. This effort began in July 1975 and is a program designed "to coordinate existing federal resources administratively in order to encourage residents in natural medical trade areas irrespective of geopolitical boundaries to take an integrated and holistic view of health care system requirements and priorities." As a part of the initiative more than 100 developmental grants will be awarded in FY 1976 to encourage formation and integration of rural health system.

Another recent effort which potentially impacts rural health care systems is the National Health Planning and Resources Development Act of 1974.

This act is designed to provide a comprehensive means for addressing equal access to quality health care a reasonable cost. The legislation provides the mechanism for establishing systems for planning, implementation and evaluation of health care delivery in this country. In addition, the legislation sets as a national priority improved health service and care for rural and underserved populations (Public Law 93-641). Therefore, the implications if this act for resolving some of the health care problems of rural areas are significant.

Findings for Health Needs of Rural Areas

In conclusion, an examination of the health conditions, resources and services of rural areas indicates that the health care problems and needs of those populations are signficant. Comparative analysis of the health conditions of rural versus urban populations has shown higher infant and maternal mortality rates and greater incidence of chronic conditions in rural populations. Rural nonfarm residents have greater injury rates and a greater percentage of medical disqualifications for military duty than do their urban counterparts.

The health resource information for rural areas indicates a shortage and maldistribution of physicians (particularly specialists), dentists and allied health manpower in rural compared to urban areas. Statistics show a greater number of community and psychiatric hospital beds per capita for rual populations compared to urban populations. However, the accessibility of these facilities in terms of location, available transportation systems and costs for utilizing the facility services present severe problems for many individuals residing in rural areas. In addition, the emergency medical services for rural populations appears inadequate.

Finally, information on the extent of utilization of health services by rural populations shows that those populations tend to visit physicians, specialists and dentists with less frequency than urban residents. However, the hospitalization rates for rural non-farm residents and rural farms residents over 65 are proportionately greater than those of metropolitan populations.

The information concerning health conditions, resources and services points to the following health care needs for rural populations:

- need for increased primary health care specialists and dental services based on the inadequate number of physicians, higher hospitalization rates, greater incidence of infant and maternal mortality, and higher incidence of medical disqualification for military duty;
- need for greater economic and physical accessibility to medical facilities and services due to maldistribution of facilities and physicians, the distances rural people must travel, inadequate transportation services or alternatives, and lower insurance subscribership and economic deprivation of some rural populations;
- need for emergency medical services due to chronic illness conditions, injury rat, and distances to facilities; and
- need for continuing medical education for physician, specialists and allied health manpower based on physician isolation, physician (specialist) shortages, lack of accessibility to medical peer consultations and referrals.

In light of these needs and the recent federal legislation relevant to the health care problems of rural areas, it is important to evaluate existing communications experiments as a health service delivery tool for rural populations.

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APPENDIX D

TECHNOLOGY

This Appendix describes the technologies included in the assessment and comments upon some of the economic factors governing their use. The technologies described are:

- coaxial cable (cable television)
- translators
- telephone
- microwave
- communications satellite
- fiber optics

Coaxial Cable

Cable television depends on coaxial cable which consists of a metallic shield and a hardwire core separated by insulating material. The cable distributes signals collected at a central point (headend) to the viewing audience. Cable systems were initially developed to provide service in small towns. Today, more than two decades after the first systems began operation , almost half of the 3000 systems in operation still serve towns with less than 1000 subscribers (1).

Twenty million homes are now within reach of cable and about 10 million subscribe to the service at rates of $5-10 per month (1). The capital investment per home served averages around $100 and ranges from approximately $500 in sparsely settled areas (15-20 households per square mile) down to $40 in more densely settled areas (greater than 1000 households per square mile). Cable plant costs are $3000 and up per mile (2-67). Because of these high costs, cable installation's are generally made only in areas with population densities of at least 30-40 households per cable mile (2-4). Although 30-40 households per mile is a rough rule of thumb used by private cable operators, it has been suggested that, in rural areas, as few as 7 subscribers per cable mile (14 households per cable mile at 50 percent penetration) may be economic (3-107). The reduced costs of installation in easily accessible rural areas is one factor favoring the lower figure.

More than two-thirds of the cable systems in operation have a channel capacity of less than twelve channels. More typically, the capability is on order of six channels. By comparison, coaxial cable now available offers the capability of furnishing 30 to 40 full television channels.

Translators

Federal Communications Commission Rules and Regulations define translators as broadcast stations "...operated for the purpose of retransmitting the signals of a television broadcast station, another television broadcast translator station, or a television translator relay station by means of direct frequency conversion and amplification of the incoming signals..." (4-74701). Translators are used to receive signals at strategically located points and to distribute those signals to areas where acceptable signals cannot be received directly from the originating broadcast station. Distribution is accomplished by "translating" the signals to another channel to avoid interference with the originating station, and rebroadcasting the signal over the air. One translator is required for each signal received and rebroadcasted.

As stated in Broadband Communications in Rural Areas prepared by the Denver Research Institute (2-4):

> "Translators provide the lowest cost way of providing one-way broadband service in rural areas. In Utah, which has a well-developed translator network, virtually the entire population receives several channels of television, and cable television has made few inroads. In countries such as Japan, extensive translator networks provide television service in rural areas at low cost."

The capital costs per household to supply six channels of television with good signal quality in sparsely settled areas (15-20 households per square mile) will range from $10-50 depending on the equipment used and the height of the broadcast antenna. These costs will be approximately $70 in communities with 100 homes and $7 in communities with 10,000 homes (2-35).

Although approximately 3000 translators are in operation in the United States, there is no accurate estimate of how many households depend on translators for television service (5). Several factors, such as regulatory impediments (discussed in the next section) and the fact that subscriber revenues are difficult to obtain since those not paying can still receive the signal, have limited the use of translators in the United States (2-5).

Two technical considerations limit translator use. First, as mentioned above, because translators broadcast over the airwaves, anyone can pick them up making it difficult to collect revenues. This could be remedied with "scramblers" which would make the signal meaningless for television sets without decoding equipment. Such equipment could be charged for monthly as in cable systems. However, hardware costs are about $50 per household, a cost which might be reduced by further technical development (2-5). (Scramblers would also require regulatory changes.) Another technical characteristic of translators is that signal quality degrades so as to be unusable after several translations. One reason is that translators use amplitude rather than frequency modulation. Another is the simple and relatively inexpensive design of many translators (2-5). If translators are to see more frequent use in rural areas, the tradeoffs in these characteristics should be examined.

As indicated previously one translator is required for each signal. Signals from more than one translator can be transmitted from a given antenna. However, spectrum availability limits the number of channels which can be provided to six to eight. There is the possibility of more in very remote regions (2-4).

Translators provide one-way signals to the consumer. Return capability could be provided via telephone.

Telephone

The telephone system depends on a variety of transmission media to transmit voice and data. Signals are distributed locally over small gauge, narrowbandwidth copper wires; transported intermediate distance by coaxial cable trunks; and transported long distances by terrestial, or satellite-borne, high frequency (microwave) radio systems. Telephone systems have effectively served the general public (more than 94 percent of the households in the United States), business and government. New services are being continually proposed (e.g., automatic meter reading) to more efficiently utilize the extensive local residential distribution network.

However, as stated by the Denver Research Institute (2-6).

> "It is unlikely that telephone lines can be used for video signals in analog form or with present digital coding techniques. As digital telephone systems are introduced in rural areas subscriber response capability for applications such as polling could be provided for minimal additional distribution plant cost. However, because subscriber response services have not yet been defined as a need or a potential market, current digitally-based telephone systems designed for rural areas do not provide such capability. There is potential for shared telephone and television plant as the technology of digital television transmission is further developed over the next ten to twenty years."

Microwave

Integration of rural telecommunications systems; whether cable or translator, both can be accomplished with microwave relay systems (however, present regulations prohibit such use for translators). Microwave relays are used for transporting large amounts of information point-to-point over line-of sight distances (15-30 miles) or further if repeaters are used.

Capital costs for transmit-only or receive-only equipment for transporting 12 television channels, using 10-foot dish antennae are $80,000-$100,000 each. Repeaters (receive/transmit stations) cost approximately $160,000-200,000 each (2-95ff.). For two-way communications, transmitter and receiver equipment would be required at each location. It is also possible for subscribers to lease channel space on established common-carrier microwave systems. The typical rate for one-way, CATV-type service, if, for example, eight channels were transported 100 miles, would be approximately $20 per channel-mile per month, or $16,000 per month. Rates will vary as a function of distance and number of channels (6).

Communications Satellites

A communications satellite serves as a microwave relay in space. Such satellites are placed in a geostationary orbit so that their position remains fixed over a particular location on earth. Because microwave repeaters transmit along a line-of-sight path, location of such repeaters on a satellite permits coverage of a large portion of North America by each repeater, rather than, as in land-based relays, requiring one repeater every 20 to 30 miles.

Receive-only earth stations are now available for $65,000-75,000 and can be located at the head-end of a single cable television system or centrally located to provide direct service to a number of cable systems. Alternately, cable or terrestial microwave systems would be used to transport the signals from the earth receiving station to the head ends of these systems. Although regulations do not currently permit such use, the signals could also be distributed by translators.

It is currently very unlikely that in the United States signals will be distributed directly to home receivers from broadband satellites.

Development of a $50-200 home receiving unit would require a capital investment of $100 to 400 million, exclusive of satellite costs, to reach the three percent of U.S. households not currently receiving any television (2-6).

Fiber Optics

Recent developments in fiber optics, light emitting diode and laser technologies make it possible to consider glass fibers as a communications medium much sooner than has been predicted. According to statements in a recent issue of the Bell Lab News reliable fibers can now be fabricated reproducibly through which light can travel over a half a mile and lose "less intensity than it would in passing through ordinary window pane". The problem of splicing optical cables, one of the major obstacles in the development of optical communications, appears to have been resolved. Powerful and reliable semiconductor light sources; methods of encoding information on the light beam; and repeaters, to amplify or regenerate signals weakened by travelling great distances, have all been developed in recent years. Light detectors, needed at the receiving end to convert the coded information back into electrical signals compatible with the rest of the network, have been available for a number of years. Once all of these elements are tied together into an economical system it will be a communications system with the potential for carrying far more information than any available today. Fiber optics could eventually be used to distribute television signals at costs lower than coaxial cable distribution costs. Some perspective on the potential impact of fiber optic communications can be obtained from the following table which compares telephone, coaxial cable and fiber optical systems.

Table D-1

Comparison Of Telephone, Coaxial Cable And Fiber Optics Technologies

TYPE OF SYSTEM →	TELEPHONE WIRED PAIR	COAXIAL CABLE CATV TYPE	FIBER OPTICS	
			LED LIGHT SOURCE PHOTO DIODE DETECTOR	LASER LIGHT SOURCE AVALANCHE DIODE DETECT
Transmission Medium Diameter (in mm)	2	13	.02	.02
Bandwidth (in M Hz)	.004	300	10-20$^{(3)}$	(4)
Approximate number of TV channels	0$^{(1)}$	30-40	2-3 Analog 1 Digital	10 Digital
Throughput Capacity (in mbps)	.0048$^{(2)}$	300	100	1000
Capacity of Cable with Dia = CATV Coaxial (in mbps)	.150-.250	300	3-5x10^7	3-5x10^8
Repeater Spacing (in km)	1.8	.5	10	10
Approximate Present Costs (per meter)	$.05	$.70-.80	1.00^{(5)}$ (typical cable)	1.00^{(5)}$ (typical cab
Approx. No. TV Channels for Cable with Dia. = CATV Coaxial	0$^{(1)}$	30-40	Analog: 600,000$^{(6)}$ -1,500,000 Digital: 300,000	Digital: $^{(6)}$ 3,000,000 -5,000,000

Notes:

(1) Can be increased under special conditions.

(2) Recent developments suggest that one TV channel can be transmitted over short distances.

(3) Will vary according to light intensity and distance.

(4) Analog service will probably not be considered.

(5) .10/meter anticipated when production quantities achieved.

(6) Provided to illustrate potential. Cables of this size may not be practical.

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